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THE AMERICAN LINE STEAMSHIP "ST. PAUL," on Aug. 14, arrived at Sandy Hook in 6 days and 31 minutes from Southampton. The course covered was 3,046.1 knots and the average speed was 21.08 knots per hour. On Aug. 13 she made a record of 530.8 knots. The highest horsepower developed was 20,800, with a highest steam pressure of 198 lbs. per sq. in.; the average revolutions of the screws were 90½ per minute, with a maximum of 93 revolutions. The sea was generally smooth and weather favorable, with some fog, which caused a slight delay. The "St. Paul" thus lowers by one hour and 53 minutes the record made last week by her sister ship, the "St. Louis," and lowers her own previous fastest trip by one minute less than five hours. The average coal consumption on the "St. Paul" was 315 tons per day.

THE HAMBURG-AMERICAN STEAMSHIP "Fuerst Bismarck" has made a new record of six days, 9 hours and 43 minutes, from Southampton to Sandy Hook. The average speed was 19.85 knots per hour. Her best previous record was 6 days, 10 hours and 32 minutes. The White Star steamship "Britannic" also lowered her former best record, of 19 years ago, by reaching Sandy Hook from Queenstown in 7 days, 7 hours and 31 minutes. She landed her passengers before sunset on Thursday, Aug. 13, and lowered her own record by about 3½ hours. She encountered heavy fogs for several days.

THE U. S. ARMORED CRUISER "BROOKLYN" will leave the Cramp ship building yard on Aug. 22 for her trial trip off the Massachusetts coast. The course is from Cape Ann to Cape Porpoise, a distance of 41.5 knots. The dimensions of the "Brooklyn" are as follows: Length on load water line, 400 ft. 6 ins.; extreme beam, 64 ft. 8¼ ins.; mean draft, 24 ft.; displacement, 9,271 tons. The four engines are of the twin screw vertical triple-expansion type, with 16,000 I. HP.; she has a normal coal supply of 900 tons and a bunker capacity of 1,753 tons. The contract speed is 20 knots; but 22 knots is expected in the trial. Her main battery contains eight 8-in. breech loading rifles and twelve 5-in. rapid-fire guns; the secondary battery includes twelve 6-pdr. and four 1-pdr. rapid-fire guns, and four Gatling guns. She has five torpedo-tubes, and the armor is 3 ins. thick on the sides, 5½ ins. on turrets and 8 ins. and 4 ins. on the barbettes, with 6-in. and 3-in. protection decks. The "Brooklyn" will carry 46 officers and 515 men, and the hull and machinery were contracted for at $2,986,000 and the keel was laid on Aug. 2, 1893. The ship is designed to have a radius of action of 1,758 knots at full speed and 6,088 knots at a speed of ten knots.

THE CAISSON ACCIDENT, in the Brooklyn Navy Yard, is still under investigation. Civil Engineer A. G. Menocal, U. S. N., in his testimony, gives his figures and reasons for assuming that it would be safe to entirely remove the stone ballast before substituting concrete. According to the published testimony Mr. Menocal estimates the water pressure against the caisson at about 740 tons, producing "a friction" on the rubber gasket, between the caisson and the dock of 370 tons. To this friction he added the weight of the caisson itself, which was 225 tons. The buoyancy of the caisson was 390 tons and he thus assumed a margin of safety, against lifting, of "over 200 tons," which he considered safe enough. Mr. Menocal charged the accident to the extreme heat, which tended to soften the rubber in contact with the heated plates of the caisson. Civil Engineer F. C. Prindle, U. S. N., testified that the removal of the ballast was the cause of the accident, and he could not think of any other cause; in his experience the total removal of the ballast was unprecedented in a similar operation. Judging from results alone, the slightly slower method of gradually replacing the stone by concrete would have been the safer method, and would have altogether avoided any reliance upon risky factors of frictional safety.

A NICARAGUA CANAL, says the Panama "Star and Herald," is to be cut by the Nicaraguan government to connect Pearl Lagoon with Pine Lagoon, and give access to the first lagoon from Bluefields, through Pine Creek. The canal would be about three miles long, and Mr. Frank Field is named as the contractor.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a head collision Aug. 15 at Torch, W. Va., on the Baltimore & Ohio Southwestern Ry. An eastbound fast freight train had run past the place where it had orders to wait for a westbound express train, and the two trains collided. Both enginemen and the fireman of the express were killed, and three other trainmen were seriously injured.——A westbound express train on the Denver & Rio Grande R. R. was wrecked near Pueblo, Colo., Aug. 15, owing, it is thought, to distortion of the rails by the great heat. The engineman and fireman were killed and about 20 passengers slightly injured.——A passenger train on the Lake Shore & Michigan Southern Ry. was wrecked near Otis, Ind., Aug. 13 by the collapse of a culvert which had been washed out by a sudden storm. The engineman and fireman were killed.

A HEAD COLLISION OF ELECTRIC CARS occurred on the Brunswick Traction Co., between New Brunswick and Milltown, N. J., Aug. 16. One car was trying to reach the next turnout beyond the one at which it should have waited for the other car.

A BOILER EXPLOSION occurred Aug. 13 at the brick and tile works at Louisville, O., and two men were fatally injured.

A STEAM ROLLER RAN AWAY on Glenmore Ave., New York city, recently, and went down a bank into a gully.

A COLLISION BETWEEN LAKE STEAMERS occurred in the Lake St. Clair channel on the night of Aug. 14, and both vessels were sunk in 17 ft. of water, but nobody was killed. The vessels were the "Oceanica," 1,490 tons, with coal from Buffalo to Chicago, and the "William Chisholm," 1,581 tons, with ore from Marquette to Ohio ports.

A HEAVY STORM in the neighborhood of Pittsburg, Pa., on Aug. 13, caused a flood in Pine Creek, and five persons were drowned at De Haven.

A DYNAMITE EXPLOSION at New Holland, Pa., on Aug. 17, killed three men, injured seven others and caused considerable damage to property. The Pennsylvania Telephone Co. is rebuilding its line between New Holland and Lancaster, and uses dynamite in blasting out the post holes. The gang was preparing to start out to work and one man had gone into the shed to fetch the dynamite when the explosion occurred.

AN INTEROCEANIC ROUTE is to be maintained by the National Railway of Tehuantepec, which has been leased by the Mexican government to Weetman, Pearson & Son, of London, for 50 years. This company, which has contracted for many large public works in Mexico, will improve the railway terminals and harbors at Coatzacoalcos on the Gulf and Salina Cruz on the Pacific.

CONCRETE AND STEEL IN COMBINATION has been adopted with success on some of the sewers built by the Metropolitan Sewerage Commission of Boston. One of the main outlet sewers built by the commission at a point where it crossed private property in Mattapan came within 8 ins. of the surface, and at a time when the sewer was flowing very full the internal pressure became sufficient to break the arch of the sewer and flood the land adjacent to it. To prevent a recurrence of the accident Mr. Wm. M. Brown, Jr., Superintendent of the Metropolitan Sewerage Commission, purchased about 4,500 sq. ft. of expanded metal, bent this to the arch of the sewer and built a new 8-in. concrete roof, embedding the expanded metal in the concrete and placing it about 2 ins. from the outside of the arch. The expanded metal extended from the crown of the arch to the springing line on each side, and its strength is such that no fears are entertained as to the safety of the arch in future. We are informed that on other sections where similar trouble was experienced the sewer was entirely relocated and rebuilt at a lower grade for a considerable distance. The expense involved in this was, of course, far greater than in the simple repair with expanded metal described above.

MAIL SERVICE BY ELECTRIC CARS has now been in operation in Brooklyn, N. Y., for two years, having been commenced on the Atlantic Ave. R. R. in August, 1894, the cars running between the general Post Office and Coney Island. The service gave satisfaction to the postal authorities, and it was not long before there was a demand for its extension to other parts of the city. The first step in that direction was in the transportation of mail pouches on the front platforms of cars, but later arrangements were made with the Brooklyn Heights R. R. Co. for the running of mail sorting cars over several of its lines. Of these cars there are now seven in regular operation, and by means of them a great saving of time in the distribution of mails is effected. The original electric mail service on the Atlantic Ave. R. R. is no longer maintained. The contract was not a liberal one from the company's point of view, being based on the amount of mail mater carried, estimated in pounds or tons, and the new management felt that the company was not getting enough out of it to make it worth while to continue the arrangement.

A 30-STORY OFFICE BUILDING is to be erected on Park Row, New York city, on the site of the old International Hotel, and will be about 386 ft. high from the curb line. There will be 27 main floors and three floors in side towers, 30 in all. The foundations consist of piles driven into the sand, cut off below the water line and covered with the concrete and masonry bases for the columns. The outer walls will be carried by cantilevers, as in many other tall buildings of this character. The architect is Mr. R. H. Robertson, of New York city.

HARD VS. SOFT WOOD FOR STREET PAVING has been considered by a special committee of the Paddington Vestry, London. In this parish the past practice has been to use soft wood with Portland cement joints. The surveyor of the parish reports that the life of this pavement is shorter than it was some years ago, owing to increased traffic, a higher standard of surface demanding more frequent repairs, and a decrease in the quality of the wood used owing to increased demand. The committee finds the present life of this soft wood under heavy traffic to be only six years, against 15 years for hard or jarrah wood pavement; and this committee finds a saving in cost in using the latter and recommends that all wood roads be renewed as soon as practicable with the best jarrah wood.

DR. FRIDTHOF NANSEN, says a special despatch to the "St. James Gazette," has arrived at Vardoe, an island on the coast of Norway. According to the meagre reports current he left his specially-constructed ship, the "Fram," in March, 1895, and attempted to push towards the North Pole over the ice which his ship could not penetrate. Nansen claims to have attained latitude 86° 14′ N. This is 2° 50′ further north than the 83° 24½′ attained by Lockward and Brainard, of the Greely expedition in 1883. In 1891 Lieut. Peary reached latitude 83° 24′ N. From the point named some members of the expedition returned south to Franz Joseph Land and Dr. Nansen and Lieutenant Hansen reached Norway on the steamer "Windward," which had been conveying provisions to the Jackson-Harmsworth expedition. The "Fram" is supposed to be on her way to Vardoe or Bergen. Dr. Nansen sailed from Vardoe on July 21, 1893, intending to reach an alleged open sea north of the 82nd degree of latitude and to drift in the ice across the Pole. It may be stated that some of the reports concerning the manner of Dr. Nansen's undoubted return are contradictory, and nothing is known of the fate of his companions left on the "Fram."

THE BLOOMING DEPARTMENT OF THE TROY Steel Company was started for the first time on Aug. 8. This new plant was commenced in September, 1895, and the machinery was built by the Mackintosh-Hemphill Co., of Pittsburgh, Pa., from the plans of Chief Engineer Arnold, of the steel company. The plant includes a pair of 42 × 60-in. reversing engines and in full operation the output of finished steel will be 800 tons per day. In making Bessemer steel the vessels are lined with calcine dolomite, instead of silica, ground fine, mixed with gas-tar and pressed into bricks under 500 tons pressure. The entire plant is expected to be in operation in about a month, employing 1,200 men.

ORE HOISTING AND CONVEYING MACHINERY AT ASHTABULA, OHIO.

We illustrate herewith an ore hoisting and conveying apparatus designed and built by the King Bridge Co., of Cleveland, O., and located on the ore docks of the Pittsburg, Youngstown & Ashtabula Ry., at Ashtabula, O., operated by Messrs. M. A. Hanna & Co., a firm whose senior member is not unknown to fame. The King Bridge Co. has a wide reputation as a builder of bridges, but it has also built quite a number of conveying machines of the general class represented, the earliest having been built in 1882. The present design contains a number of improvements suggested by the company's experience.

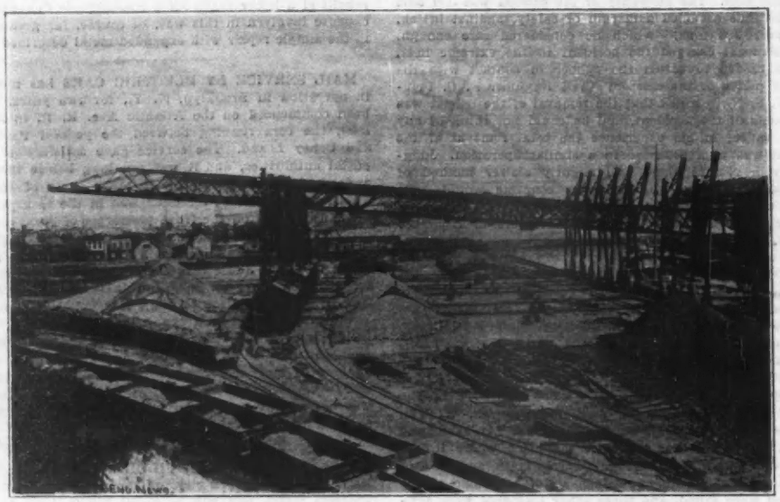


FIG. 1.--ORE-HANDLING MACHINERY ON PENNSYLVANIA CO.'S DOCKS AT ASHTABULA.
Designed and Built by the King Bridge Co., of Cleveland, O.
(Span between Towers, 180 ft.; Cantilever, 88 ft.; Apron in front, 34 ft.)

The structure, as now built, contains eight separate bridge trusses, each 180 ft. long, between the towers, with a cantilever 88 ft. long projecting over the rear tower and a folding apron 34 ft. long on the front tower, which can be raised and lowered so as not to interfere with the masts of vessels when they are taking position at the dock. The bridges are arranged in pairs, that is two of them have a common support in a tower at the rear, while there is a separate support or leg at the front for each bridge. The complete plant thus contains four towers at the rear and eight legs at the front. All of the towers and legs are supported by wheels on tracks consisting of two rails at the rear and one in the front. The moving of the plant from one point to another is done by steam or electric power applied to the wheels at the rear, and by hand gearing at the front.

The bridges are hinged to each side of the top of the rear tower and at the top of the front tower they are hung by means of adjustable connections. This mode of attachment allows the bridge or projecting apron, without being strained in the least, to be operated directly from the hatchway of a boat without moving the whole machine. There is a clear space under the bridges from top of the dock of about 30 ft., giving room for storage purposes, when it is not convenient to unload a vessel directly into the cars. The bridges are on a grade in order to increase the storage capacity of the dock.

The machinery is all operated from the engine room, where it is under the constant watch of the engineer. Outside of the engine room, on the bridge, there are only the sheaves and steel ropes.

The hoisting engines used on the plant described are of the Lidgerwood pattern, with reversing gear, and these, with the boilers, are placed in an engine room built in the rear tower. The rear tower is also propelled up and down its track on the dock by a gearing located in the engine house, from which power is furnished to raise and lower the apron at the front tower. The bridge is constructed with an upper and lower runway, the upper forming the track for the hoisting and the lower for the conveying carriage, from which are operated wire conveying ropes to which the buckets are attached. The hoisting drums can be so operated that the bucket is hoisted and conveyed at the same time, taking the shortest line between two points, and be stopped at any height and place. It does not need to be hoisted into contact with the carriage before the conveying takes place and it requires no latch mechanism, such as is usually employed in machinery of this description.

When the plant is completed with ten legs it will have more than ample capacity to unload the ore boats of the most recent design, which have 12 hatches and measure 432 ft. in length over all, with a capacity of 6,680 net tons of ore on 19 ft. draft.

Concerning the actual operation of the plant as now built, with eight legs, Mr. Geo. B. Raser, the manager of the dock at Ashtabula, says, that on Sept. 26, 1895, the steamer "Roman," with 2,500 tons of ore, commenced unloading in cars at 6.30 a. m. and finished at 5.30 p. m., and on Sept. 28, 1895, the steamer "German," with 2,540 tons of ore, commenced unloading in pile at 7 a. m. and finished at 5.30 p. m. An allowance in each case should be made for shut-down of one hour at noon, and in neither of these cases was any special effort made to obtain a record or special good showing. These boats were unloaded into cars standing on the two tracks near the water front, and not into the pile, and there is always a loss of from 30 to 50% of time occasioned in pulling out the loaded cars and replacing them with empties. The time thus lost it is the intention to save by laying two additional tracks for cars, besides the two now used, so that two cars may be placed under each hoist at the same time. One of these cars may be loaded while the other one, being full, is being replaced by an empty.

The general arrangement of machinery, mode of operation and important details and safety devices are all covered by the Rasch and other patents controlled by the King Bridge Co. The company intends hereafter to operate this branch of its business extensively. It is also at present engaged in perfecting a coal handling device for unloading cars directly into boats.

TRACK ELEVATION, CHICAGO & NORTHWESTERN RY., IN CHICAGO.

(With Inset.)

The only railway company now prosecuting the work of track elevation in Chicago is the Chicago & Northwestern, which has about 3.6 miles of its Milwaukee Division undergoing this improvement. In previous issues* this journal has outlined and discussed the scope and progress of the work of abolishing grade crossings which the great western metropolis has undertaken, and where conditions permitted a definite statement the structural details of the work have been described. Compared with the task as a whole the progress thus far made seems small, but it is great in its promises of future results. Opposition and delay on the part of several of the railways entering the city will doubtless continue, but the larger number show a disposition to consider the question broadly and fairly and to meet the city half way in its efforts to solve a pressing and difficult problem. Among this larger number the Chicago & Northwestern Ry. Co. is notable for having taken up the work with good will and energy. This company has already elevated 1.85 miles of its line, is now at work on an additional 3.6 miles, and has contract to elevate another section of its line in the near future. In the following paragraphs the work of the Chicago & Northwestern Ry. is

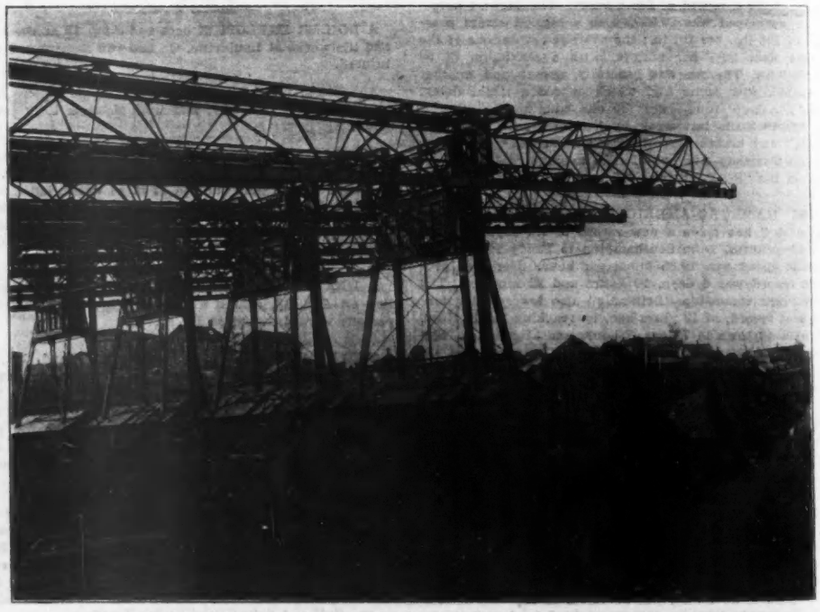


FIG. 2.--VIEW OF REAR TOWERS AND OPERATING HOUSES.

*Engineering News: March 9, Oct. 5 and 19, 1893; April 26, July 19 and Oct. 11, 1894; Jan. 23, 1896.

described as completely as its present progress and available information will allow.

The Chicago & Northwestern Ry. system radiates west and north from Chicago in three main lines from the passenger station at Wells St. and Fifth Ave., just north of the main branch of the Chicago River. From the Wells St. station the Galena Division or line extends almost directly west. The other two lines have a common right of way northwest from Wells St. station to Clybourne Junction, about three miles, and then separate, one line going north to Milwaukee and thence to northern Wisconsin and Michigan, and the other northwest to St. Paul and Minneapolis. For sake of brevity in the following description these lines will be designated as the Galena, Milwaukee and Wisconsin lines, respectively.

The first work of track elevation done by the Chicago & Northwestern Co. was on the Galena line, and comprised the raising of about 1.85 miles of five-track railway, the construction of six new subways for crossing streets, and the remodeling of a seventh subway. The general character of the subway constructions, except that at Sacramento Ave., which was built in 1893 (Eng. News, Sept. 21, 1893), and is only remodeled in the present construction, is shown by the accompanying table:

Name of street.	Elevation, track.	Depression, street	Length, floor.	Length, inclines.	No. tracks, bridge.	Span of bridge.	No. of spans.
	ft.	ft.	ft.	ft.		ft.	
Kedzie Ave.....	10.69	3.82	130	110	5	66	1
Homan Ave	11.3	3.5	149.7	100	5	66	1
St. Louis Ave	11.59	3.18	150	91	5	50	1
Central Park Blvard..	11.16	2.34	120	115	5	92	2
Hamlin Ave	11.3	3.22	120	92	5	80	3
W. 40th St.....	8.5	6.1	306	175	9	66	3

Note.—The grade of all inclines is 3.5%. The names of some of these streets have been changed since the work was begun. At Sacramento Ave. the roof of the subway was raised 3½ ft. and its floor a corresponding distance.

It will be seen that the work naturally divided itself into two processes: (1) The construction of the subways at street intersections, and (2) the elevation of the tracks between the cross streets. As the subway construction can be better described later on it will be left for the present and attention turned to the elevation between streets. This was simply earth embankment work; and according to the terms of the ordinance signed with the city, retaining walls were to be built wherever necessary to keep the embankment within the limits of the company's right of way. This right of way is only 100 ft. wide, and with only five tracks retaining wall was needed only along a part of the distance, but some time in the future when other tracks are added the wall will be extended as needed. These walls were built of limestone masonry with a concrete footing and present no features out of the ordinary.

Probably the most interesting part of the embankment work was the method of filling adopted. Fig. 1 shows this method quite clearly. The bottom solid line shows the original grade of the tracks and the top solid line the grade after elevation. The broken lines show the different sections of the embankment numbered in the order they were built. For example, triangles No. 1 were first built with sand hauled by train, the tracks being raised little by little until they conformed to the grade indicated by the line A, B, C, D, E. It will be noticed that the tracks crossing Kedzie Ave., at C, had not been elevated thus far, but now the girders for the two outside and the center tracks, with floor system, tracks, etc., complete, were brought to Kedzie Ave. mounted on jacks on flat cars, and were hoisted onto temporary pile abutments, but not up to full grade. Two tracks, it will be noticed, were unobstructed by this work. The girders being hoisted to their temporary positions, triangles 2, 2 were filled in, which as the quantity was small, was done in one day. The tracks now followed the grade A, B, F, D, E, and the trains run over the two outside tracks and the center track. The bridges for the remaining two of the five tracks were then raised onto their temporary abutments. Everything was now ready for filling the irregular prism 3, raising the bridges to full grade, and the girder erection at Homan Ave., after which triangles 4 and 5 were filled, and so on west until the work was completed.

This method was new with this work so far as we know, and proved decidedly efficient. Only one street was closed at a time, the grade was never greater than 1%, and not more than 1,500 ft. of track was unsurfaced at one time. In the elevation now in progress on the Milwaukee line practically the same method of filling is being used, except that as there are here only three tracks the fill for each track is brought to its full height before the track is swung to one side and up onto it. This means that all three tracks are swung a distance equal to the distance between centers of tracks to one side.

Attention will now be turned to the track elevation on the Milwaukee line which is in progress. Altogether there are 3.6 miles of three-track line to be elevated, comprising the construction of 20 subways and about 300,000 cu. yds. of fill. Not all of this work will be done this season, however; only 12 subways and about 153,000 cu. yds. of filling being now contemplated. The general method of embankment construction has already been described, and need not be mentioned further.

Out of the total 20 bridges to be constructed across intersecting streets, 13 will have spans of 66 ft., five spans of 80 ft., one a span of 100 ft. and one a skew span of 139 ft. These last two spans will be included in the work now under construction, but all the other bridges built this year will have spans of 66 ft. Generally the streets will be depressed from 2 ft. to 4.5 ft., only five being changed more or less than these amounts. The track will be elevated about 9 ft. above its present grade and the clearance of the subways will be generally 10 ft. or 12 ft., only two structures having a greater clearance, 13.5 ft. All 66-ft. streets are to be crossed by a single span, but two or more spans will be used for streets of greater width.

For the purpose of illustration one of the 66-ft. bridges will be used, as the others differ from them only in size. The city ordinance required simply that the bridges have iron or steel girders, watertight floors, and masonry or masonry and metal column foundations. This is essentially the construction adopted. Fig. 2 shows the girder and floor construction in detail, and Fig. 3 gives an enlarged detail of the track construction particularly is noticeable. The floor beams consist of two channels riveted back to back with a filler plate between, extending to within about 1 ft. of the beam ends. These beams are fastened to gusset plates, which slip into the spaces left by the filler plate at each end of the beam, and are spaced 5 ft. c. to c. The stringers consist of two 6×16 ins. oak timbers carried in a trough formed by two Z-bars and a plate, and riveted to the floor beams. Between the oak stringers the space is covered with 3-16-in. deck plate which closes the floor solid and prevents dripping of dirt or water onto the subway floor beneath.

It will be seen that there are several advantageous features to this floor. It has a small depth, gives an even distribution of the wheel loads, is very simple to construct and erect, and is not of excessive weight, 540 lbs. per ft., in proportion to its supporting strength. The wooden stringer gives an elastic rail bed and tends to reduce noise. To this latter condition the division of the floor plates into comparatively small sections also contributes. The designer of this floor was Mr. Louis H. Evans, M. Am. Soc. C. E., Engineer of Track Elevation, Chicago & Northwestern Ry.

The design of the subway bridges having been explained attention may be turned to the method of erecting them. From the shops of the Lassig Bridge Works, Chicago, the builders, the various parts are shipped assembled in convenient sections to the erecting yard of the railway company. Here is located the erecting frame shown by Fig. 4, by means of which the two girders and floor system for one track are erected complete. Blocked up on two flat cars, the structure weighing 70 tons, about, is conveyed to the bridge site, where everything has previously been put in readiness for its reception.

At the bridge site the first work is to excavate under the tracks, keeping them all the time blocked up to carry the traffic, and then to build the concrete foundations for the abutments. There being three tracks, piles are then driven at each side of the proposed line of one of the side tracks and at each end of the bridge site, which will serve as temporary abutments. As shown by Fig. 5 the flat cars carrying the bridge for this track are backed onto the site; the bridge raised off them by screw jacks and blocked up on the piles; and finally the cars pulled from under. It will also be noticed from the illustration that the embankment has been brought up to the bridge site in the direction of progress and is held by a timber bulkhead. As soon as the cars are withdrawn a similar bulkhead is built at the end opposite the first and the filling begins so that the track may be carried over the bridge and onward. By the method of filling before described, it requires only a few trainloads of dirt to accomplish this end. Inside the timber bulkheads the masonry abutment work is also progressing.

The bridge for the other outside track, consisting of two girders and a floor system, is placed in exactly the same manner as the first. There remains then only the work of putting in the floor system for the center track, which is done on the bridge site, as clearly shown by Fig. 6. The completion of the abutments, the leveling and testing of the bridge, and the depression of the street now remains.

Fig. 7 is a view of one of the bridges with the abutments nearly completed and the street depression in progress. As the abutment foundations are completed before the bridge is placed, there only remains the masonry walls to be built. An I-beam is attached to the bottom of the bridge, so as to extend transversely across it about over the line of the facing course of masonry. On this runs a trolley which carries a pulley hoist, for handling the stone. The stones are brought to the site on cars and unloaded by a wrecking crane. From the stone pile a fixed derrick supplies the stone to the trolley hoist.

The street depression is simple excavation, about the only difficulties encountered being the occasional changing of water and sewer pipes. It is required by the ordinance that the grade of the approaches shall be 3½%, and that the width of roadway and sidewalks shall remain unchanged. The approaches are to be paved as was the original street, but the subway floor proper is to have a vitrified brick pavement laid on ½-in. of sand on a 6-in concrete foundation. Drainage is to be provided for by suitable catch basins and connections with the sewer.

In the foregoing, reference has been had to single span 66-ft. subways only, and as already stated the work comprises one 100-ft. span and one 149-ft. skew span subway. Fig. 8 shows the bridge for the 100-ft. span subway, and explains clearly the center column support and the apparatus used in the masonry construction. The 149-ft. subway is located where Lincoln Ave. joins Addison St., at an angle, and its outside or longest bridge girder is 235 ft. As indicating the rapidity of work, the bridge (one track), of which this girder is a part, was erected ready for traffic in five hours from the time it left the erecting frame in the yards. The regular rate of progress for 66-ft. bridges is seven single-track bridges erected in six days. About 3,000 cu. yds. of sand are hauled by train and put into the embankment each day and the contractors for street depression add to this about 1,000 cu. yds. per day. This makes the rate of progress 6,500 lin. ft. per month of three-track, 66-ft. right of way elevated 9 ft.

Altogether the work now in progress on the Milwaukee line will cost about $1,000,000, and as will be inferred from the foregoing it is entirely north of Clybourne Junction, where the Wisconsin and Milwaukee lines join to enter the city station. In the same manner the elevation of the Wisconsin line will begin north of Clybourne Junction and extend north, unaffecting the common line from the Junction south. No work has been done on this line, but the ordinance providing for its elevation has been passed by the Chicago City Council, and the construction it requires is in all respects similar to that just described. There will be 26 subways, including one subway for pedestrian travel only. Of this number 18 will have bridges of 66-ft. span, five bridges of 80-ft. span, one a bridge of 73-ft. span, one a bridge of 100-ft. span, and one, the foot subway, a bridge of 10-ft. span. The length of line to be elevated will be 4.6 miles. It is not definitely known when work will begin on this line.

as the ordinance requires simply that it shall be completed within eight years, but the policy of the railway company seems to be to get the work accomplished as soon as practicable and it is entirely possible that the summer of 1897 will see it begun.

For the information from which this article has been prepared we are indebted to Mr. Louis H. Evans, M. Am. Soc. C. E., Engineer of Track Elevation, Chicago & Northwestern Ry.

TEST OF WATER-BEARING GRAVEL AT BEAVER FALLS, PA.

An interesting test to determine the quantity and quality of water that could be obtained from water bearing gravel, at Beaver Falls, Pa., was conducted in 1894, by Jas. H. Harlow & Co., of Pittsburg. The gravel in question overlies a blue silt, practically impervious to water, which, in turn, overlies sandstone rock, about 40 ft. below the surface, and was located at the junction of Wallace Run and the Beaver River. The test showed that a sufficient quantity of water for a small water-works plant could be secured but that a large part of the water came from the river, which is polluted with sewage and likely to become more so.

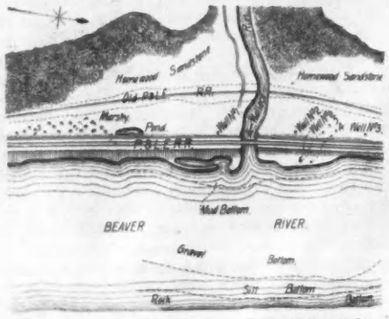


Fig. 1.—Plan Showing Location of Test Wells at Beaver Falls, Pa.

James H. Harlow & Co., Pittsburg, Engineers; Simon Harrold, Beaver Falls, Contractor.

The following particulars regarding the test are taken from the report on the subject, made by the engineers to the officials at Beaver Falls.

The site chosen for the test was selected in accordance with the best data available, and in accordance with a belief that the gravel stratum overlying the rock was exposed at the surface of the bed of Beaver River.

The two streams, Wallace Run and Beaver River, are described in the report as follows:

Wallace Run enters the Beaver River from the west, and and drains about three square miles of farming country. The stream descends rapidly from its source and flows over a broken surface of soil and rock. At the mouth of the Run no water has been visible for the past month and if any water is passing down the Run it is below the surface.

The Beaver River, above the mouth of Wallace Run, has a drainage area of 2,964 sq. miles, about 1,600 miles of this being within the state of Ohio. Within this drainage area we have, as per census reports of 1890, 255,732 population, an average of 86.3 per sq. mile. This population has undoubtedly increased within the four years that have elapsed since 1890, and by 1900, if the increase in population be the same as the last decade, we may expect at least 300,000 population. During the decade of 1880 to 1890 nearly all of the increase within the drainage area of the Beaver River was within the following cities and villages, viz.: Newcastle, Pa.; Greenville, Pa.; Butler, Pa.; Sharon, Pa.; Youngstown, O.; Niles, O.; Warren.

The average increase of the above places for the past decade was 70%, and we may expect a similar increase for the present decade, or in 1900, when these places will probably have a population of at least 130,000.

The tests for capacity were conducted under the supervision of Mr. H. F. Labelle, Principal Assistant to Jas. H. Harlow & Co. The plans, as carried out, provided for the sinking of four wells to rock and of a fifth well, 8 ins. in diameter, at such a point in relation to the others as should finally be deemed best for the pumping trial. The specifications for the pumping test provided for 20 days continuous pumping and stated that:

If for any reason caused by defective machinery or negligence of the contractors or their employees the pump shall be stopped at any time for a period exceeding one-half hour, it shall be optional with the engineer to begin a new test, and no payment shall be made for any pumping that may have been done previous to the beginning of this new test.

The test was to be made with a pump having a capacity of not less than 250 gallons per min., or 360,000 gallons a day.

The arrangement for measuring the pumpage from the wells is described in the report as follows:

The pump was to discharge into a measuring flume at one end of which was a weir similar to that used by Francis and others. This flume was 16 ft. long, 3.71 ft. wide, 1.75 ft. deep, inside dimensions. The weir was placed 1.29 ft. above the bottom of the flume and had a length of 1.005 ft. Across the bottom of the flume and 2 ft. from the weir was placed a ¾-in. pipe plugged on the end inside the flume, and the open end extending through the side of the flume into a gage box. In this pipe were drilled several ⅛-in. holes to admit the water and show the depth on the weir. In the gage box was fastened a glass tube which was connected to the open end of the ¾-in. pipe by gum tubing. The zero of the glass gage coincided with the weir, and by noting the height of the water in the glass gage the depth of the water on the weir was ascertained. In the gage box was placed, in addition to the glass gage, which was read direct, a Bristol's recording gage. This gage makes its own record on the circular card which was rotated once in 24 hours by clock work. The records for this gage were failures, and have not been given in the accompanying tables. The object of this recording gage was to show if any stoppages occurred during the absence of the assistant, and to give the time such stoppages did occur. The gage did show when the pump stopped, but not accurately the depth on the weir and the only advantage gained by its use was its moral effect on the man in charge of the pump, as he did not know of its inaccuracy.

The water from the well enters the opposite end of the flume from the weir, and of course entered with considerable force. To make the water approach the weir uniformly and quietly there were placed across the flume three wire screens of ⅛-in. mesh.

After advertising for bids the contract for sinking the wells and making the pumping test was awarded to Mr. Simon Harrold, of Beaver Falls. The first well was begun on June 11, and the five wells were completed about July 1. The wells are shown in plan by Fig. 1, and in section by Fig. 2. The stratification at the first four wells is indicated by the sections, Fig. 2, the elevations being heights above sea level. The depth of each stratum for the various wells are extracted from the reports, slightly condensed, as follows:

No. 1.—2.5 ft. of vegetable ground; 6 ft. yellow loam; 5.6 ft. fine sand with some water; 7.4 ft. coarse sand and fine gravel; 17.3 ft. blue silt, this silt lying on sandstone rock, which is yellow in color; total depth, 38.8 ft.

On June 13 the water stood in well No. 1 at elevation 735.23, the water in the river being 735.01, showing water was 0.22 ft. above that in the river.

No. 2.—2 ft. of vegetable ground; 4.8 ft. loam and stones, some gravel, water put into casing disappearing immediately; 8.7 ft. sand, without much gravel, water bearing; 7.1 ft. of coarse sand and small gravel; 18.4 ft. blue silt similar to No. 1; 3.5 ft. fine gravel to rock, light gray in color; total depth, 42.5 ft.

No. 3.—21 ft. of sandy loam, with the sand increasing gradually downward; 1 ft. sand and gravel; 8.7 ft. sandy loam, merging into gray silt at the bottom, where light gray sand and rock was found; total depth, 30.7 ft. The casing of this well was afterwards withdrawn.

No. 4.—6 ft. of sandy loam; 10 ft. sand and gravel; 43.5 ft. blue silt similar to Nos. 1 and 2, merging into blue clay, with a little gravel at the bottom of the well. This silt overlies a sand rock light gray in color.

Well No. 5 was sunk to within 2 ft. of the top of the flue silt. It showed practically the same stratification as well No. 4. The well was 8 ins. in diameter, cased, the lower 5 ft. of the casing being pierced with 1,400 holes, each 3-16 ins. in diameter, and the extreme end of the casing being roughly plugged with stone to prevent the admission of sand.

Owing to trouble with the pumping plant the contractor did not start his 20-days run until July 25.

The weir discharges were computed by the Francis formula,

$$Q = 3.33\,l^{\frac{1}{3}}L,$$

with corrections for end contraction and velocity of approach.

The detailed results of the capacity test are given in tables accompanying the test. The yield decreased from some 340,000 gallons per 24 hours for the first two or three days, to 215,000 gallons at the end of the test.

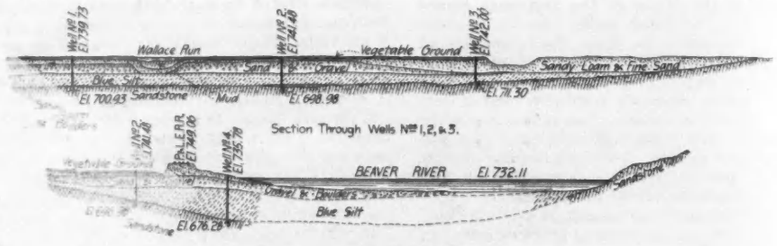


Fig. 2.—Sections Through Test Wells.

The report states that with a 5-ft. head the quantity of water that could be depended on within a radius of 175 ft. from the pumping well, which was the range of influence of the pumps, would be about 260,000 gallons a day. The conclusion is reached that

it is probable a number of wells can be distributed along the bank of the Beaver River and into this same sand and gravel bed, and almost any quantity of water obtained, at least as long as the river lasts.

No comments are made regarding the effect of pumping on well No. 3. As to No. 1, the report expresses the belief that it "had no direct connection with the sand strata pumped from," water in this well usually standing above that in the river.

Wells Nos. 2 and 4 generally rose and fell with river, if the pumping was continued at a uniform rate. On one day the river rose at the rate of 0.1 ft. in eight hours, and the water in wells Nos. 2 and 4 about 0.08 ft. in the same time, the rate of pumping meanwhile increasing about 10,000 gallons an hour.

Another confirmation of the connection of the wells with the river was the temperature observations. When pumping was begun, the temperature of the water in well No 5 was 57° F., and in the river 76°, a difference of 19°. When pumping was stopped, on Aug. 14, the well water had a temperature of 71° and the river water 77°, a difference of only 6°.

Passing from the quantity to the quality of the supply, the report gives the results of chemical tests made by Mr. Jas. O. Handy, Chemist of the Pittsburg Testing Laboratory. These are reproduced in the accompanying table. Sample No. 1 was selected as indicating the character of the river before being affected by the salt wells on the Connoquenessing, and by the sewage of Butler, Pa. It was tested for chlorine, only, which seems unfortunate, since a test for organic matter would have aided in judging how much of the increase in chlorine was due to sewage contamination. Sample 3, from the test well, was taken from the discharge pipe of the pump. Sample 4 was selected as representing the character of the water being supplied to the borough by the water company at the time of the test. It was supposed to have passed through Hyatt filters at the pumping station. Before taking it the water was allowed to run long enough to fully remove the water which had been standing in the service pipe.

Chemical Analysis of Crude and Filtered Beaver River Water at Beaver Falls, Pa.
(Parts per 100,000.)

	No. 1.—Beaver R. above the Connoquenessing.	No. 2.—Beaver R. at mouth Wallace Run.	No. 3.—Test well No. 5.	No. 4.—Faucet in Todd's drug store, Beaver Falls, Pa.
Albuminoid ammonia		0.0208	0.0138	0.0220
Free ammonia		0.0192	0.0266	0.0032
Nitrites		small	high	high
Nitrates		none	trace	trace
Chlorine	2.68	11.42	8.98	12.57
Sulphate of lime	6.80	6.82	6 02	6.31
Carbonate of lime	4.53	4.53	4.85	4.51
Sulphate of magnesia		1.07	0.00	1.19
Carbonate of magnesia		0.08	0.50	0.01
Chloride of magnesia		2.03	3.28	2.14
Sodium chloride		18.35	14.81	18.11
Sodium carbonate		6.38	1.91	9.45
Silica		0.26	0.40	0.28
Oxide of iron and alumina		0.28	0.00	0.20
Total		40.70	31.77	43.10
Hardness		14.4	13.90	14.22

The engineers' comment upon the analysis is as follows:

Chlorine.—Chlorine in No. 1 is an indication of probable sewage from the towns above the Connoquenessing, but in samples Nos. 2, 3 and 4 the chlorine represents largely the salt, which is known to come from wells on the Connoquenessing. Sample No. 4 has the largest amount, and it is possible the difference between it and No. 2 is due to sewage entering below Wallace Run. Sample No. 3 has the lowest of any below the Connoquenessing, and this difference is probably due to the admixture of ground water into well No. 5 from the sandstone hillside. We think in this instance there is no special difference in the several waters, if the high amounts show an excess of salt, which is harmless.

If we can assume that there was but little chlorine in the water that came from the sandstone, we may estimate from the amount of chlorine in samples Nos. 2 and 3, that 90% of the water pumped was from the river, and 10% from the hillside. We are inclined to think, however, that more than 90% of this water comes from the river.

Ammonias.—As the figures stand, sample No. 3, as shown by the albuminoid ammonia, is the best. If the water is largely river water (No. 2) it shows that it has been oxidized in passing through the sand. If there is a considerable amount of land water, as indicated by the chlorine, this lower amount may mean dilution only.

The albuminoid ammonia in sample No. 3, taken in connection with the free ammonia and high nitrites, would seem to show that the organic matter had been partially filtered or to a considerable extent oxidized, but that the oxidation was still going on, and is incomplete.

Sample No. 4 seems to be substantially the same water as sample No. 2, the albuminoid ammonia being practically the same. The low free ammonia and nitrites would seem to show that decomposition by oxidation had not yet begun, or at least carried to any great extent. The low amount of free ammonia may be accounted for (as it is a gas) by having been agitated in some manner, possibly by passing through pumps. The sum of ammonias is the sum of the decomposing and decomposed organic matter which may be either animal or vegetable. The former decomposes with much more rapidity than the latter, and contains much more nitrogen. In the case of sample No. 2, from the Beaver, which flows generally in a rapid stream, and at the time of the year when the streams are low and vegetation active, and considering that within the drainage of the Beaver are several large towns each of which have sewerage systems discharging into the river, we may conclude that the large amount of ammonia is an indication of sewage contamination. In a water at Lawrence, Mass., that was polluted to such an extent as to cause a great deal of sickness, 0.0037 free ammonia, and 0.0158 albuminoid ammonia was found, the sum of the ammonias being 0.0195. This is much lower than any samples that we have.

Lime.—The sulphate and carbonate of lime both cause scale in boilers and from a manufacturing standpoint should be gotten rid of. To a city largely given to manufacturing, it is important that these should be disposed of, even if at considerable expense. The sulphate of lime deposits a hard scale that has to be removed by the use of considerable force. The carbonate of lime deposits a soft scale that can usually be blown off with the water and steam, if this is done often enough. Samples Nos. 3 and 4 are practically the same in this respect.

Sodium Chloride.—This is common salt, and the quantity shown here is not noticeable to the taste and is not harmful.

Sodium Carbonate.—This is known in commerce as sola-ash and is used in making soap and glass. It has a tendency to neutralize the lime and soften the water. Nos. 3 and 4 are practically the same as far as relates to these substances.

Bacterial examinations of water from four sources were made by Dr. E. G. Matson, Professor of Pathology in the Western Pennsylvania Medical College, Pittsburg, Pa., with the following results:

Sample No.	Source.	Bacteria per cu. cm.
1.	Beaver River at Wallace Run	892
2.	Test well No. 5	874
3.	Test well No. 2	327
4.	Faucet in Todd's drug store, Beaver Falls	475

Samples Nos. 1, 2 and 4 correspond, respectively, with samples Nos. 2, 3 and 4 of the chemical tests. The water from the river and main well (No. 5) contain what Dr. Matson regards as a suspiciously high number of bacteria, and there is no material reduction of bacteria in the passage of the water from the river through the gravel to the well. Sample No. 3 is also condemned as being river water insufficiently filtered in its passage through the gravel. The number of bacteria in the city water does not reflect with certainty the efficiency of the filters, as the relation between the crude and filtered samples is uncertain and there may have been bacterial changes in the water while passing through the pipes.

The final conclusions drawn by the engineers from the pumpage, chemical and bacterial tests, and such surveys, borings and river soundings as were made, are as follows:

(1) That the water from the test well at the mouth of Wallace Run is clear and limpid so far as can be discovered by the naked eye.

(2) That the water obtained from the sand strata at the mouth of Wallace Run is mainly from the Beaver River. This is shown by the physical, chemical, and bacteriological examinations.

(3) That the quantity of water obtainable from the sand strata at the mouth of Wallace Run and above is practically limited only to the quantity flowing in the Beaver River, and the possibility of the surface of the gravel being covered with an impervious deposit brought down during floods.

(4) That the water in the Beaver River is contaminated by sewage from the towns above, and to an extent that is dangerous.

(5) That the water now delivered to your citizens is substantially Beaver River water, and that its quality might be improved upon.

(6) That if no other supply of water can be found other than the Beaver River, Wallace Run is a proper location for the works, and by a properly designed system of filtration the water can be purified of its sewage and lime, so that it will be fit for domestic and manufacturing purposes.

(7) The sand strata would clarify the water so as to make considerable less work for the filter, and reduce the cost of operation.

We would, however, advise some other source of a water supply if it can be found.

PAST AND PRESENT TENDENCIES IN ENGINEERING EDUCATION.*

By Mansfield Merriman, M. Am. Soc. C. E.**

The present status of engineering education in the United States is the result of a rapid evolution which has occurred in consequence of changes of opinion as to the aims and methods of education in general. These changes of opinion, whether on the part of the public or on the part of educators, together with the resulting practice, may be called tendencies. All progress that has occurred is due to the pressure of such views or tendencies; hence a brief retrospect of the past and contemplation of the present may be of assistance in helping us to decide upon the most advantageous plans for the future.

Thirty years ago public opinion looked with distrust upon technical education. Its scientific basis and utilitarian aims were regarded as on a far lower plane than the well-tried methods of that venerable classical education whose purpose was to discipline and polish the mind. What wonderful changes of opinion have resulted, how the engineering education has increased and flourished, how it has influenced the old methods, and how it has gained a high place in public estimation, are well known to all. The formation of this society in 1893, its remarkable growth, and the profitable discussions contained in the three volumes of its transactions, show clearly that technical education constitutes one of the important mental and material lines of progress of the nineteenth century.

Engineering courses of study a quarter of a century ago were scientific rather than technical. It was recognized that the principles and facts of science were likely to be useful in the everyday work of life and particularly in the design and construction of machinery and structures. Hence mathematics was taught more thoroughly and with greater regard to practical applications, chemistry and physics were exemplified by laboratory work, drawing was introduced, and surveying was taught by actual field practice. Although engineering practice was rarely discussed in those early schools, and although questions of economic construction were but seldom brought to the attention of students, yet the scientific spirit that prevailed was most praiseworthy and its influence has been far reaching.

This scientific education notably differed from the old classical education in two important respects: first, the principles of science were regarded as principles of truth whose study was ennobling because it attempted to solve the mystery of the universe; and second, the laws of the forces of nature were recognized as important to be understood in order to advance the prosperity and happiness of man. The former point of view led to the introduction of experimental work, it being recognized that the truth of nature's laws could be verified by experience alone; the latter point of view led to the application of these laws in industrial and technical experimentation. Gradually the latter tendency became far stronger than the former and thus the scientific school developed into the engineering college.

The very great value of laboratory experiments, and of all the so-called practical work of the engineering school of to-day, is granted by all. Principles and laws which otherwise may be but indistinct mental propositions are by experimentation rendered realities of nature. The student thus discovers and sees the laws of mechanics, and is inspired with the true scientific spirit of investigation. It should not, however, be forgotten that if such practical work be carried beyond the extent necessary to illustrate principles, it may become a source of danger. The student of average ability may pass a pleasant hour in using apparatus to perform experiments which have been carefully laid out for him, and yet gain therefrom little mental advantage. Especially is this true when the work assumes the form of manual training which, however useful in itself, is properly considered by many as of too little value to occupy a place in the curriculum of an engineering college.

The tendency toward the multiplication of engineering courses of study has been a strong one, especially on the part of the public. This has resulted in a specialization that, as a rule, has not been of the highest advantage to students. In some institutions this has gone so far that the student of civil engineering learns nothing of boilers and machines, while the student of mechanical engineering learns nothing of surveying or bridges. The graduate is thus too often apt to lack that broad foundation upon which alone he can hope to build a successful career.

The development of the scientific school into the engineering college has been characterized throughout by one element of the happiest nature, that of hard work and thoroughness of study. The numerous topics to be covered in a limited time, their close inter-relation, and the utilitarian point of view, have required many hours per week and earnest work by each student in preparation for each exercise. The discipline of hard and thorough work is one whose influence can scarcely be overestimated as a training for the duties of life, and in every university it is found that the activity and earnestness of the engineering students is a source of constant stimulus to those of other departments. Thus scientific and engineering education has tended to elevate the standard and improve the methods of all educational work.

The length of the course of study in engineering colleges has generally been four years, and whatever tendencies have existed towards a five-years' course have now for the most part disappeared. With higher requirements for admission, particularly in English and in modern languages, a reduction of the length of the course to three years may possibly be ventured in the future, particularly if the long summer vacation be utilized for some of the practical work, as indeed is now the case in several institutions.

There has been and now is a strong tendency toward a reduction in the length of the college year. While formerly forty or forty-two weeks were regarded as essential, the process has gone on until now some colleges have but thirty or thirty-two weeks, a reduction of nearly twenty-five per cent. having been effected in twenty-five years. Undoubtedly the long vacation is utilized to great advantage by the majority of students in actual work, yet the fact remains that it is not good business economy to allow the buildings and plant of a college to lie idle for so large a part of the year. It is perhaps possible that in the future the summer schools may be so developed that the work will be practically continuous throughout the year, thus giving to students the option of completing the course either in three or four years.

The report of the committee on requirements for admission, which will be presented later in the session, sets forth many facts which show the tendencies now existing. Almost without exception a higher standard is demanded, both that students may enter with better mental training, and that more time may be available in the course for technical subjects. While the general line of advance is toward an increase in mathematics and in modern languages, there is also found, particularly in the central states, a demand for broader training in science. It has already been pointed out that our early engineering schools were strong in scientific training, and that the tendency has been to replace this by industrial applications. If the requirements for admission can be extended to include the elements of chemistry and physics, with some botany or zoology, the engineering student will enter with broader views, a keener power of observation, and a scientific spirit, that will greatly increase his chances for success in technical studies.

The general increase in requirements for admission tends to raise the average age of the student. It is now usually the case, owing to the greater length of time needed in preparatory work, that the average age of the classical student is one year higher than that of the engineering student; or the former has had one more year of training than the latter. One more year of training means much as an element for success; one more year in age means an increase in judgment, which is of the highest importance for a proper appreciation of the work of the course. The older men in a class usually do the best if not the most brilliant work, and after graduation their progress is the most satisfactory. It thus appears that all tendencies that raise the age of entrance are most important ones and deserve hearty encouragement.

*Presidential address before the Society for the Promotion of Engineering Education at the meeting in Buffalo, N. Y., Aug. 20, 1896.

**Professor of Civil Engineering in Lehigh University.

Having now considered some of the general elements and tendencies in engineering education, it will be well to take up the program of studies, especially in regard to those subjects that are common to all technical courses. The three volumes of the transactions of this Society, contain many carefully prepared papers and interesting discussions which enter into questions of detail concerning nearly all topics in the curriculum. Here, however, can only be noted briefly the main lines of development and the indications for future progress.

Mathematics is undoubtedly the most important subject in all courses of engineering study, and it has been demanded for years that it be taught with great thoroughness. This demand has been met more completely in the independent engineering colleges than in the engineering courses of the universities. Much, however, remains to be done in this direction, and probably it cannot be satisfactorily accomplished until a change in method has been effected. The fundamental element in the charge of method must be, it seems to me, in a partial abolition of the formal logic of the text-books, and an introduction of historical and utilitarian ideas. Mathematics is a tool to be studied for its uses, rather than for its logic or for the discipline that it can give; hence let its applications be indicated frequently and not be systematically kept out of view. If the student gains the impression that his mathematical exercises are merely intended to train the mind, his interest and his progress will usually be slow. If, however, he learns what mathematics has done in the past, how it joins with mechanics to explain the motions of the distant planets, as well as to advance the material prosperity of man, there arises an interest and a zeal that helps him to overcome all difficulties.

The great advantage of numerical exercises in all branches of pure and applied mathematics, and the deplorable lack of good preparation in arithmetic have been expressed by many educators. In numerical computations the average engineering student is weak in spite of the numerous exercises in his practical work. To remedy this defect better instruction in arithmetic is demanded in the common and high schools, while in engineering colleges the teachers of mathematics should constantly introduce numerical work and insist that it be done with a precison corresponding with the accuracy of the data.

Next to importance in mathematics comes mechanics, the science that teaches the laws of force and motion. In most institutions the rational is separated from the applied mechanics and often taught by the mathematical department. Probably less improvement has resulted in the teaching of rational mechanics during the past quarter of a century than in any other subject. That mechanics is an experimental science whose laws are founded on observation and experience is often forgotten, and the formal logic of the text-books tends to give students the impression that it is a subsidiary branch of mathematics. The most interesting history of the development of the science is rarely brought to the attention of classes, and altogether it appears that the present methods and results are capable of great improvement.

It should not be overlooked, however, that in recent years the so-called absolute system of units has been introduced into mechanics, and is now generally taught in connection with physics. Here the pound or the kilogram is the unit of mass, while the unit of force is the poundal or the dyne. Although this system possesses nothing that is truely absolute, it has certain theoretical advantages that have commended its use, notwithstanding that no practical way of measuring poundals has been devised except by the action of the force of gravity on the pound. Engineers have continued to employ the pound weight as the unit of force, and the calculations of the physicist must be translated into the units of the engineer before they can be understood. The student of rational mechanics thus has the difficulty at the very outset of two systems of units, and great care should be taken that each be thoroughly understood and the relations between them be clearly appreciated by application to many numerical problems. In view of these and other difficulties, and of the novelty of the subject in general, it appears that some engineering colleges do not give to rational mechanics as much time as its importance demands.

Physics in some colleges, is taught by a course of five or six exercises per week, extending over a year, while in others the elements are required for admission and the regular course is correspondingly abridged. The marvelous development of electrical theory and practice has naturally tended to make this the most important topic in the course, sometimes indeed to a material abridgment of mechanics, acoustics, thermodynamics and optics. Considering how great is the importance of each branch of physics and the advances that are made every year in new directions, it may also be concluded that more time can be profitably given to both theory and to experimental work. Physics is a fundamental subject whose principles and results are of constant application in every walk of life, and a student who thoroughly covers a well arranged course has gained a mental discipline and a scientific habit of mind that will be of greater value than the technical details of a purely engineering specialty.

Undoubtedly the most powerful tendency in engineering education has been in the direction of the development of those special technic subjects which may be grouped under the name of Construction and Design. In civil engineering this has led to plans for railroad, water supply, and bridge constructions; in mechanical engineering to engine and machine design, in mining engineering to projects for mine plants, and in electrical engineering to the design of dynamos and motors. These courses have been demanded by the public and by the students themselves, and have been often elaborated to an extent beyond the best judgment of teachers of engineering. To the extension of such courses there is no limit, but it is a question whether the process has not already gone too far. For instance, it would not be difficult to arrange a course of twenty or thirty exercises on water pipes in which should be discussed all the methods of manufacture and processes of laying cast-iron, wrought-iron lap-welded, steel-riveted, and wooden mains, together with a comparison of their relative economies under different conditions in different parts of the country. These lectures, however, would plainly be of such a technical nature that the advantage to the student would be slight; they would give valuable information but little training.

In all courses in construction and design the practical limit seems to be reached when the exercises are of such a nature as to give mere information and little scientific training. The aim of all education, and of engineering education in particular, should be to render the student conscious of his mental power and sure of applying it with scientific accuracy so as to secure economy of construction. Fundamental principles are hence more important than the details of a trade, and all exercises in design should be arranged so that the student may think for himself rather than blindly copy the best practice of the best engineers.

The subject of applied mechanics, which occupies an intermediate place between rational mechanics and the work in design, has been so differentiated that the mechanics of materials is now almost the only topic common to all engineering courses. The strongest line of development has here been in the introduction of testing machines and in the making of commercial tests. This work is of high value, although it may be doubted if the use of one or two large testing machines is as advantageous as that of many smaller ones which are designed especially to illustrate principles. The student of the present day enjoys, however, advantages that were unknown a quarter of a century ago, and the marked progress in applied mechanics, from both the scientific and technical point of view, is a source of congratulation.

English and modern languages are generally called culture subjects, and it is well known that of all the topics in the engineering course these are the ones in which students have the least interest. The great importance to an engineer of being able to clearly and correctly write his own language can scarcely be overestimated. Further it may be said that no engineer can hope to attain eminence unless he can read German and French literature. These opinions have long been held, and furthermore it has been recognized that engineering students and graduates are often lacking in that general culture which the world demands as one of the conditions of success. Great improvements have been made in the methods of teaching English and modern languages, and probably still greater ones are yet to result. In the ideal engineering colleges of the future, perhaps these subjects will be required for admission, as is now done by at least one institution, but at present they must generally be taught. The main line of improvement to secure better results will be, it seems to me, in partially abandoning the idea of culture and placing the instruction upon a more utilitarian basis. If English be regarded as a means to an end instead of linguistic drill, if the aim of teaching French and German be to read fluently the language of to-day instead of laboriously to decipher the meaning of the poets of centuries ago, true zeal on the part of students will arise and a truer culture will result.

At the close of the college course the student presents a thesis showing his ability to apply the principles and rules of engineering in the investigation or design of a special problem. The tendency has been strong to abandon subjects which involve mere description or compilation, and to insist upon those that will require the student to exercise his own powers. Thus the value of the work to the student has been greaty increased, and the theses of each class are a source of stimulus to the following ones. Although the view held by some that theses should be monographs setting forth important conclusions of original investigations, is one that can not in general be realized, it is a gratification to note that each year a few theses are produced which are sufficiently valuable to warrant immediate publication.

The formation of engineering clubs among students for the discussion of the details of professional work is one of the most important tendencies of recent years. No exercise is so valuable to a student as one entirely originated and performed by himself, and the preparation of a paper which is to be presented to and criticized by his fellows ranks highest of all among such exercises. Recently there has been forced upon my notice a remarkable activity in the three engineering clubs of a certain engineering college, more than fifty papers having been read and discussed during the year by a total of about three hundred and fifty students, besides a number of others read before the mathematical club. In meetings of this kind the scientific and economic questions under discussion in the engineering journals receive a detailed attention which the professor in the class room often finds it impossible to give, while the advantage to students in expressing themselves in debate is very great.

Occasional lectures to classes by practicing engineers have been introduced in many institutions during the past decade, and with uniformly good results. In engineering education there is no conflict between theory and practice, and every professor cordially welcomes distinguished engineers to explain their great structures and achievements to his classes. It is an inspiration to students to see and hear those men who have so successfully applied sound science to economic construction, and whose influence has been uniformly to elevate the standard of the profession.

After four years of work the engineering student receives his degree and is ready to commence the actual work of life. What the letters are that designate the degree is a matter of small importance. Moreover, if we examine the lists of the alumni who graduated ten or fifteen years ago, the conviction arises that their particular course of engineering study has not been an absolute factor in determining their actual line of engineering work. It is found that graduates in civil engineering are engaged in mining, in machinery and in electricity, and that graduates in other courses are employed upon work in which they received no especial technical instructions. Thus it appears, also, that the particular course of engineering study is not so important a matter as students and the public generally suppose. In fact a young man thoroughly grounded in fundamental principles and well trained how to apply them, has almost an equal chance for success in all branches of engineering practice.

Looking now over the field of tendency thus briefly outlined, it is seen that there has been ever present a powerful impulse towards specialization, to which, indeed, nearly all others have been subordinated. This has demanded a higher standard of admission, great thoroughness in all fundamental subjects, and a rigid adherence to scientific methods. Engineering education has had an active and healthy growth. It now enjoys the respect and confidence of the public, and its future is sure to be more influential than its past. It is not specialization that has caused its success, but rather the methods which specialization has demanded. Those methods have resulted in imparting to students zeal and fidelity, a love of hard work, of veneration for the truths of science, and a consciousness of being able to attack and overcome difficulties; these elements of character are, indeed, the foundation of success in life.

Looking now forward into the future it is seen that in our efforts for the promotion of engineering education a wide field for work still lies open. The student should enter the engineering college with a broader training and a more mature judgment. The present methods of instruction are to be rendered more thorough and more scientific. In particular, the fundamental subjects of mathematics, physics, and mechanics, are to be given a wider scope, while, the languages and the humanities are to be so taught as to furnish that broad, general culture needed by every educated man. In general let it be kept in mind that education is more important than engineering, for the number of men who can follow the active practice of the profession will always be limited. Hence let it be the object of engineering education to influence the world in those elements of character that the true engineer possesses, so that every graduate may enter upon the duties of life with a spirit of zeal and integrity, with a firm reliance upon scientific laws and methods, and with a courage to do his work so as best to conduce to the highest welfare of his race and his country.

THE RICHER TACHYMETER.

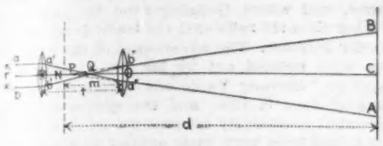
By F. D. Lyphart, C. E.

This instrument has been in extensive use in Europe for a number of years and is called after its manufacturers, Maison Richer, Guyard, Canary & Co., successors, 13 Rue de la Cerisaie, Paris. It chiefly differs from American stadia instruments in being equipped with a so-called "analytic lens." This lens is inserted in the telescope between the object-glass and the wires, and its object is to do away with the customary constant, and to afford a means of perfectly adjusting the instrument for the correct reading of

distances, simply by altering the distance of this lens from the object-glass.

The following history and theory of the tachymeter is taken from the work of Dr. Charles M. Schlos on "Surveying and Leveling." The analytic lens was originally introduced by an Italian, Prof. Porro; but it was improved upon and adapted to practical use by a French civil engineer, I. Mainot. In a work published by the latter, and describing the modified tachymeter, he gives careful hints for the employment of the instrument in the field, and for the calculation and plotting of the results of surveys made with it.*

In describing the theory of the tachymeter, for the sake of simplicity, a horizontal line of sight is assumed in the accompanying demonstrations, though the same reasoning will apply to an inclined position of the telescope. In the figure, a'



b' is the analytic lens; lines are drawn from the stadia wires a and b parallel to the axis of the telescope, and these lines, on passing through the lens meet at the focus Q. When they meet the object-glass they are again broken and strike the rod at A and B; while the projection of the latter lines it would intersect at a point P, back of the focus Q. The distance P C is proportional to the reading A B on the rods; and if the dotted line represented the axis of the instrument, we would have for the required distance d the equation:

$$d = PC + PN = kAB + PN.$$

If P N can be made = 0 the apex of the triangle A P B will be moved to the center of the instrument, and the equation will become:

$$d = PC = kAB$$

and the constant is eliminated. Since P is the vertical image of the point Q, so far as the object-lens is concerned, we have:

$$\frac{1}{OQ} - \frac{1}{OP} = \frac{1}{F}$$

F being the focal distance of the object lens, and consequently:

$$OP = \frac{F \times OQ}{F - OQ}$$

If f = the focal distance of the analytic lens and F = distance between this lens and the object-glass, we have

$$OP = \frac{F(t-f)}{F+f-t};$$

and if m is taken as representing the distance between the object-glass and the center of the instrument:

$$PN = ON - OP = m - \frac{F(t-f)}{F+f-t}.$$

With P moved to the center of the instrument:

$$PN = 0, \text{ or } m = \frac{F(t-f)}{F+f-t};$$

hence

$$f = t - \frac{m \cdot F}{m+F}$$

The above is the formula for the analytic lens. For the coefficient k, which expresses the proportions of the real distance to the reading on the rod, we have

$$k = \frac{CP}{AB} = \frac{OP}{a''b''} = \frac{F(t-f)}{F+f-t} \cdot \frac{1}{a''b''}$$

The triangles Q a'' b'' and Q a' b' being similar, we have the equation—

$$\frac{a'b'}{a''b''} = \frac{QR}{QO};$$

or, if we call the distance of the stadia wires from each other = r, we have

$$\frac{1}{a''b''} = \frac{f}{t-f} \cdot \frac{1}{r};$$

consequently,

$$k = \frac{F(t-f)}{F+f-t} \cdot \frac{f}{t-f} \cdot \frac{1}{r} = \frac{Ff}{F+f-t} \cdot \frac{1}{r}$$

or,

$$r = \frac{Ff}{F+f-t} \cdot \frac{1}{k}$$

This equation gives the distance of the stadia wires from each other for a fixed value of k, generally taken either at 100 or at 200. It is, however, practically impossible to place the stadia wires exactly at the required distance apart; and, as a rule, k is not exactly 100 or 200. The last equation but one shows, however, that k depends on the value of t, the distance between the analytic and the object lens. Consequently, by checking this distance, k can be given the exact desired value, and the instrument can be adjusted for the correct reading of distances.

By changing t, P N will not remain exactly equal to zero; but the resulting inaccuracy is so small that it may be safely neglected in stadia surveying.

In the Richer Tachymeter the analytic lens is made movable; but this arrangement is objectionable, because it is necessary to take the telescope apart to alter the position of the lens, and a perfect adjustment can only be made after several trials. It is suggested that a more convenient means could be devised which would permit a backward and forward movement of the lens, without turning around and without affecting the line of collimation.

Messrs. Buff & Berger, of Boston, refer to the analytic, or Porro lens in their "Handbook and Illustrated Catalogue," and object to it on the ground that it disturbs the line of collimation and unfits the instrument for accurate work. This is true for use where extreme accuracy is required. But the writer has found the Richer Tachymeter of great advantage in ordinary engineering surveys, and in the hands of an expert it gives surprisingly satisfactory results. It is a favorite instrument among European engineers for railway surveys in rolling or mountainous country, as it favors quick work and gives the engineers a reliable means of checking the measurements. Mr. W. F. Shunk is certainly right when he says in his "Field Engineer" that: "Astronomical nicety, whether with transit or level, in an ordinary railroad survey is a mere waste of time."

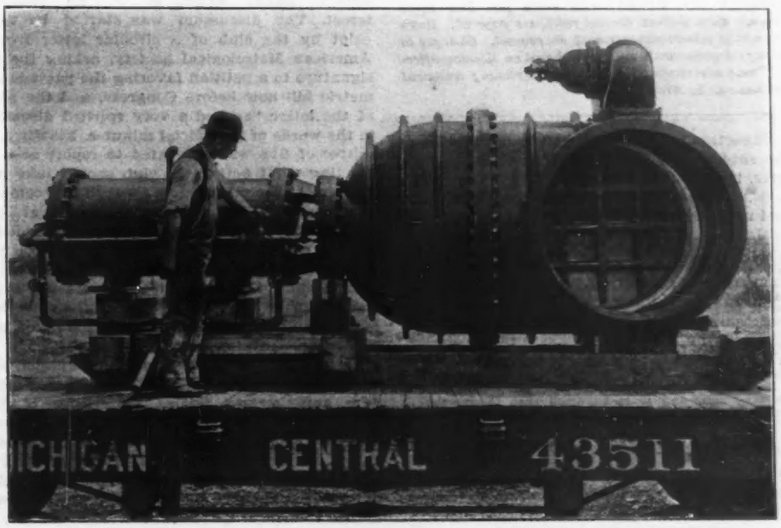
Porro's lens is objectionable, however, in causing a loss of light, just as in the case of any extra lens; and on this account it should only be used in an inverting telescope. If the figures on the stadia rod are painted upside down, much trouble, on this account, would be avoided. In the Richer Tachymeter the wires are replaced by lines etched on the plane side of the field lens of the eye-glass, which is a Ramsden lens. It is also worth mentioning that the graduation, both on limb and vertical circle is centesimal instead of sexigesimal as usual. This is done with a view of facilitating the reading of the metallic logarithmetic slide-rule which takes the place of tables in the use of this instrument. The objection to this graduation is that it makes the instrument unsuitable for running in curves and for similar purposes, especially when American field methods are employed.

*"Leves de plans a la Stadia, par J. Mainot," published by Ch. Dunod, 49 Quai des Grands Augustins, Paris.

A 42-INCH HYDRAULIC VALVE.

The time and labor required in opening or closing an ordinary geared valve on large water mains is so great that these devices do not receive, in some cities, as many tests to determine whether they are in good working order as the good of the water-works system demands. Aside from this, there are times when it is highly desirable to shut a valve very quickly, and it is always advantageous to operate the valve system or any portion of it with a minimum of time and labor. Obviously one of the simplest means of improving on gear valves operated by hand is to utilize the pressure existing in the water mains to move the valves. This has been done on a line of 42-in. pipe in Detroit, for which the Michigan Brass & Iron Works of that city has furnished twelve 42-in. valves. The same company has also made six 30-in. hydraulic valves for the water-works of Toledo, O.

One of the 42-in. valves loaded on a car for shipment is shown by the accompanying view, from which its general design will be evident. This view does not show the auxiliary hand pump through which the feed to the hydraulic cylinder is made. This pump is for use when there is no pressure on the main, or in case of some emergency. Another feature of the device not shown by the view is designed to prevent the closing the valve under pressure without having the by-pass open. To guard against this, two gages are used, one connected with the by-pass on each side of the gate. By watching the gages the operator can see whether everything is working properly, and if not he can stop the large gate by simply closing the valve on the feed or outlet gate. All the trimmings of the valve are carried on heavy bronze rollers which operate on bronze tracks imbedded in the base of the valve. All contact surfaces bring bronze against bronze. The 42-in. valve complete, without pipe, weighs 14,000 lbs.



VIEW OF 42-IN. GATE WITH HYDRAULIC PISTON ATTACHED, FOR THE WATER-WORKS OF DETROIT, MICH. Made by the Michigan Brass & Iron Works.

The pressure at Detroit is nominally 35 lbs. per sq. in. in the line on which these valves are placed. The valves there, the manufacturers state, have been closed in one minute. The time of operation, however, is under absolute control so that the valve can be moved as slowly as may be desired. For the above information we are indebted to Mr. Fred. H. Cozzens, Secretary and Treasurer of the Michigan Brass & Iron Works.

Shortly after the valves were placed at Detroit, Mr. L. M. Case, Superintendent and Secretary of the water-works, wrote us in response to our inquiry that they were giving satisfaction.

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ADVERTISING RATES: 20 cents per line agate measure. Want notices, special rates, see page 22. Rates for standing advertisements sent on request. Changes to standing advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.

In connection with the editorial in our last issue on the subject of the export of American manufactures, it is of interest to note that the Carnegie Steel Co. has just secured an order for 9,000 tons of steel rails for Japan. Concerning this the New York "Journal of Commerce" says:

> The order is for 9,000 tons for delivery up to the end of the year, and was placed with the Carnegie Steel Co. by Mitsui & Co., of Japan, after inviting bids in England and in this country. While the price paid could not be learned it may be said that the bid of the Carnegie Co. was sufficiently below the English market to justify its acceptance in spite of the higher freight rates from this country. The contract calls for 60-lb. rails. * * * *
>
> This is the second large order that has been placed in this country for steel rails on Japanese account, the Illinois Steel Co. having filled an order for 10,000 tons a few months ago, and it is expected that the steel-rail business with Japan will develop into a steady and important item of trade. It is expected that the demand in Japan for railway material will in the near future show a marked increase.

It would appear from the above item that American manufacturers can beat those of Europe in steel rails as well as in cotton cloth, even when seriously handicapped in the competition.

The paper on the pooling of freight equipment which we print on another page discusses a subject of the greatest importance to the railways of the country. There is probably not a single reform which the railway companies of the country could institute (unless it be a radical revolution in the rate-fixing and traffic soliciting departments), which would bring such great returns as a general agreement to pool freight car equipment.

We have often pointed out that the expenses of handling freight in terminals and yards are becoming a larger and larger proportion of the total freight traffic expenses. The latest statistics show that there are over one-fourth as many locomotives engaged in switching service as in road service on freight trains in the whole United States and in some sections the proportion rises to one-third. This does not tell the whole story either, for the locomotives of way freight trains spend a large part of their time in switching work at unimportant stations. An enormous proportion of this switching service would be needless if the railways would only agree upon some plan of joint ownership. And this is only one, and by no means the most important of the benefits that would result from such a system.

The fact is that the railways have progressed so far toward common use and ownership of their freight equipment, that actual joint ownership is merely an obvious next step in advance. At present the car which one railway company owns spends half or more of its time in the service of other companies, and is treated in many respects when it is away from home exactly as if it were common property. Under the proposed pooling arrangement a company owning cars would receive, it would appear, just as much revenue from them as at present, would be more sure than now of having cars to furnish its shippers in times of heavy traffic, and would share with all other railways the benefits resulting from the pooling which Mr. Cavanagh's paper well sets forth.

The fact that so many cars are owned by equipment trusts might be thought a difficulty; but this could easily be overcome by leasing the cars to the proposed joint equipment association instead of transferring them outright. It is to be hoped that the railway presidents, who have of late shown so commendable a disposition to work in harmony with each other, may see their way clear to arrange for co-operation in this important field.

The metric system and the advisability of its compulsory adoption in this country was before the Engineers' Club of Philadelphia for discussion last spring, and the July number of the club's "Proceedings," which has just come to hand, contains a report of the discussion and the action taken, which is of no small interest. The discussion was started by the receipt by the club of a circular letter from the American Metrological Society, asking the club's signature to a petition favoring the passage of the metric bill now before Congress, and the reading of the letter "evoked a very spirited discussion," in the words of the official minutes. Finally a committee of five was appointed to report at a later meeting what action the club should take in the matter. At the meeting on April 18 this committee presented a report favoring the approval by the club of the metric bill, and further extended discussion and reading of correspondence took place. It was finally decided to submit the question of the adoption of the committee's report to a letter ballot; and at the next meeting of the club the result of the ballot was announced, 100 favoring the report and 60 being against it.

From a condensed report of the discussion which appears in the "Proceedings," we find that Messrs. Wm. and Coleman Sellers, Wilfred Lewis and S. M. Vauclain were the chief opponents of the metric system. Those favoring it, on the other hand, included Mr. Geo. B. Roberts, President of the Pennsylvania R. R.; Mr. Francis Schumann, President of the Tacony Iron & Metal Co., which uses the metric system in its shops; Mr. A. Falkenau, who also has used the metric system, and many others.

A loop terminal has very generally been acknowledged to have many important advantages over a head-house or dead-end terminal, more especially for lines having a heavy traffic of one class of trains, as on city and suburban lines. These advantages are especially important in the case of elevated railways, where the great majority of the traffic is simply an in and out movement for each train, with only the switching necessary for changing engines and changing the train from the up-town to the down-town track, or vice versa. The amount of room required for the loop system, however, has generally prevented its adoption on elevated railways. In another column we describe a loop line which will be a terminal for the joint use of four elevated railways. On this line there will be a daily traffic of 1,000 to 1,500 trains, and it is a notable feature that no reverse movements will be required, the incoming trains of each line passing round the loop to the outgoing track. This is a city terminal, and there will be no changing of engines or putting on of new cars, all such work being done at points on each individual line. Apart from the great convenience which will be attained in the prompt handling of the traffic there will be a great convenience for through passengers from one part of the city to another, as they can leave an inbound train from the north or west side at a station on the loop and take an outbound train for the south side at the same station. It will be evident that to effect the necessary connections between the several lines there must be a somewhat intricate system of switches, and that to safely and promptly handle the traffic a very complete system of signaling and interlocking will be required, and these points appear to have been fully covered in the loop line above mentioned, the main principle on which the plans have been prepared being that of ensuring the greatest safety and efficiency, while the cost of the work has been but a secondary consideration. This is undoubtedly the right way to go to work, more especially in a case where there will be such a heavy traffic at the outset, and where (judging from the experience of other elevated railways) the traffic is so likely to rapidly increase. The advantages of the loop system were pointed out by Mr. W. L. Derr in a paper on "Railway Yards and Terminals," in our issue of June 9, 1896, and the system has been somewhat extensively adopted for street railways, but it has been very little applied to steam railways. In fact at present we can only mention the Chicago loop line, the loop terminal of the Brooklyn Elevated Ry. at the Brooklyn Bridge, and the terminal of the Mexican National Ry. at Manzanillo (Eng. News, July 5, 1894). An objection frequently made is the amount of space required, but this objection has been very much exaggerated, and we question whether there are many places where the system could not be applied if desired.

In the Province of Manitoba, civil engineering is now a "close profession," the government of that province having passed a law at its last session, putting certain restrictions upon the practice of engineering, in accordance with the request of a committee appointed by the Canadian Society of Civil Engineers. The work which has been done by that society toward the establishment of the engineering profession upon a similar basis to that of the other professions was summarized in our issue of April 30, 1896, and we reprint in another column the law recently passed by the Manitoba legislature. It will be noted that its provisions are exceedingly mild. It is declared in substance that after July 1, 1896, no person shall be entitled to call himself a civil engineer or to act as an engineer in connection with any public work involving over $500 expenditure, unless he is a member of the Canadian Society of Civil Engineers or of some other national society of civil engineers "of good standing," or unless he was practising as a civil engineer in Manitoba at the date of the passage of the act, or unless he is a "duly qualified civil engineer" and entitled to use the title of Civil Engineer by virtue of some statute in force in the province, or unless he holds the degree of Civil Engineer conferred by some institution of learning in the province. The breadth of these exceptions is praiseworthy; but it is also to be noted that the law provides no pains or penalties for those who disregard its provisions. It states who shall be entitled to use the title "Civil Engineer," and to practise the profession, but if any one chooses to write C. E. after his name, or to practise as a civil engineer, without the qualifications laid down, the law neither defines the nature of his offence nor specifies its punishment.

The presidential address of Prof. Mansfield Merriman before the Society for the Promotion of Engineering Education is an admirable summary of the present tendencies in engineering education in this country and it can be read and studied with profit by practising engineers as well as by the professors in engineering schools. Every engineer, so long as he continues in active practice, must be to a greater or less extent engaged in the work of engineering education—training one pupil, himself; and so long as he gains in ability, it is because, consciously or unconsciously, he is carrying on the work of self-education. We might comment upon the various topics which are brought

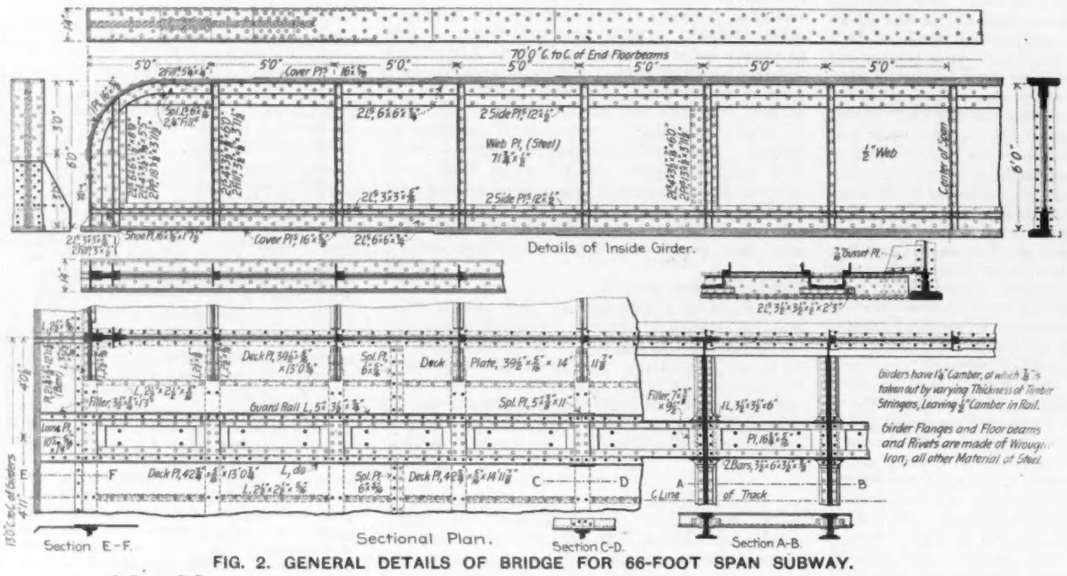

70'0" C. to C. of End Floorbeams
5'0"
Cover Pl's
Web Pl. (Steel)
7/16 x 6'0"
½" Web
Center of Span
6'0"
Details of Inside Girder.
Deck Pl. 39½" x ⅝" x 13'0"
Spl. Pl. 6½" x ⅝"
Deck Plate, 39½" x ⅝" x 14'
Guard Rail L. 5" x 3½" x ⅝"
Spl. Pl. 5" x ⅝" x 11"
Filler, 7⅞" x 9½"
Deck Pl. 42⅛" x ⅝" x 13'0⅛"
Deck Pl. 42⅛" x ⅝" x 14'11⅞"
Z Bars, 3½" x 6" x ⅜"
Girders have 1⅛" Camber, of which ⅜" is taken out by varying Thickness of Timber Stringers, Leaving ¾" Camber in Rail.
Girder Flanges and Floor beams and Rivets are made of Wrought Iron, all other Material of Steel.
Section E-F.
Sectional Plan.
Section C-D.
Section A-B.
C. Line of Track

FIG. 2. GENERAL DETAILS OF BRIDGE FOR 66-FOOT SPAN SUBWAY.

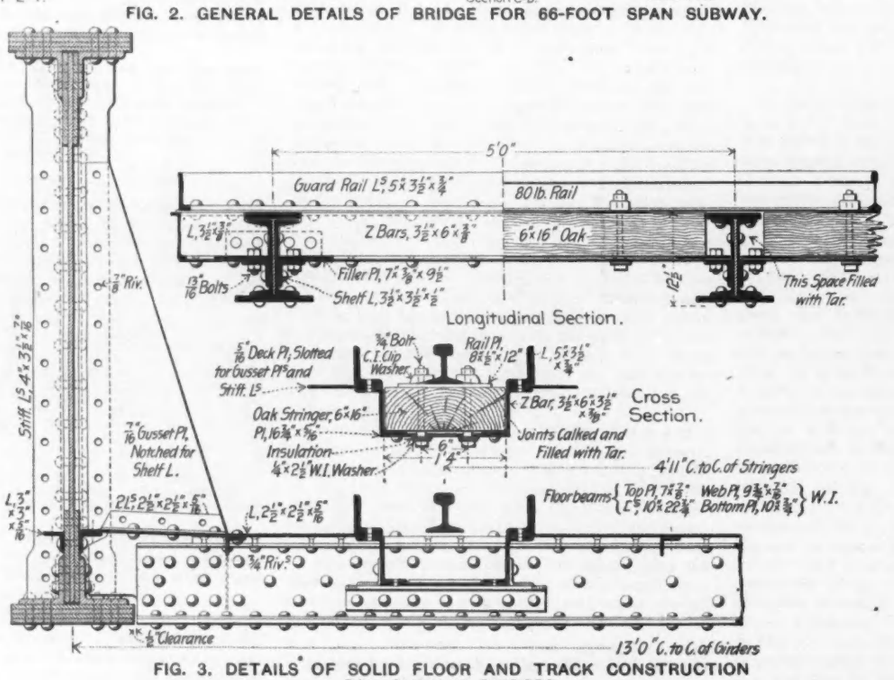

5'0"
Guard Rail L. 5" x 3½" x ¾"
80 lb. Rail
Z Bars, 3½" x 6" x ⅜"
6" x 16" Oak
13/16" Bolts
Filler Pl. 7" x ⅜" x 9½"
Shelf L. 3½" x 3½" x ½"
This Space Filled with Tar.
Longitudinal Section.
Deck Pl. Slotted for Gusset Pl's and Stiff. L's
¾" Bolt
C.I. Clip Washer
Rail Pl. 8½" x ½" x 12"
Z Bar, 3½" x 6" x ⅜"
Cross Section.
Oak Stringer, 6" x 16"
Pl. 16⅜" x 5/16"
Insulation
¼" x 2½" W.I. Washer
Joints Caulked and Filled with Tar.
4'11" C. to C. of Stringers
Gusset Pl. Notched for Shelf L.
Floorbeams
Top Pl. 7" x ⅜"
Web Pl. 9⅜" x ⅜"
Bottom Pl. 10" x ¾"
W.I.
Stiff. L's 4" x 3½" x ⅞"
¾" Riv's.
½" Clearance
13'0" C. to C. of Girders

FIG. 3. DETAILS OF SOLID FLOOR AND TRACK CONSTRUCTION FOR SUBWAY BRIDGES.

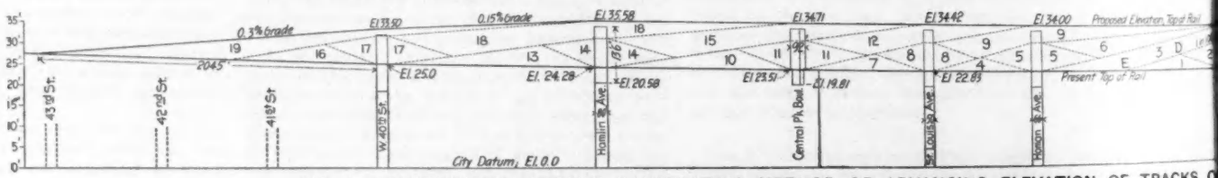


FIG. 1. CONSTRUCTION PROFILE ILLUSTRATING METHOD OF ADVANCING ELEVATION OF TRACKS O

FIG. 5. VIEW SH

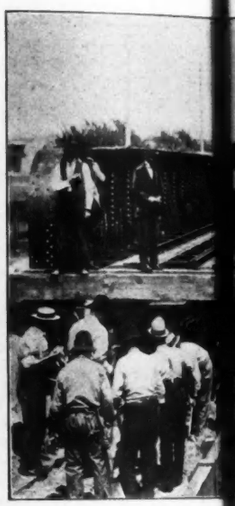
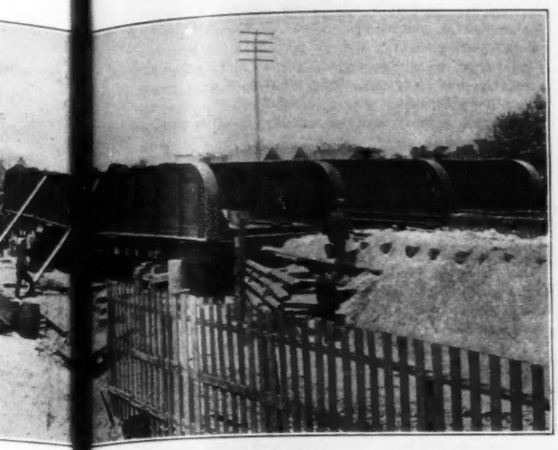


FIG. 6.

TRACK ELEVATION, CHICAGO &

J. E. Blunt, Chief Engineer, Louis H. Evans, M. Am. Soc. C. E

Lassig Bridge Works, Chicago



VIEW SH ING METHOD OF PLACING SUBWAY BRIDGE ON ITS SITE.

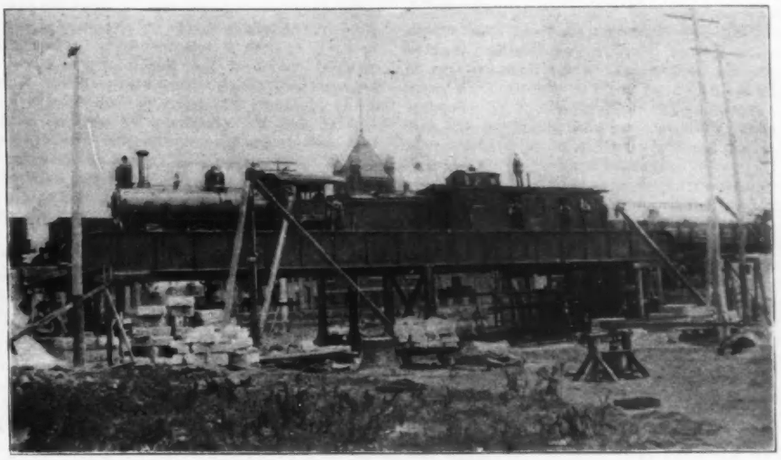


FIG. 8. VIEW OF 100-FOOT SUBWAY WITH TWO SPAN BRIDGE AT IRVING PARK BOULEVARD.

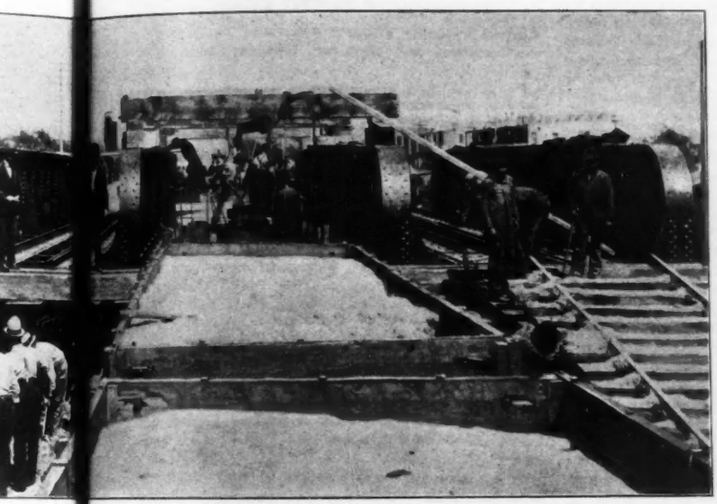


FIG. 6. EW SHOWING METHOD OF PLACING BRIDGE FLOOR FOR MIDDLE TRACK.

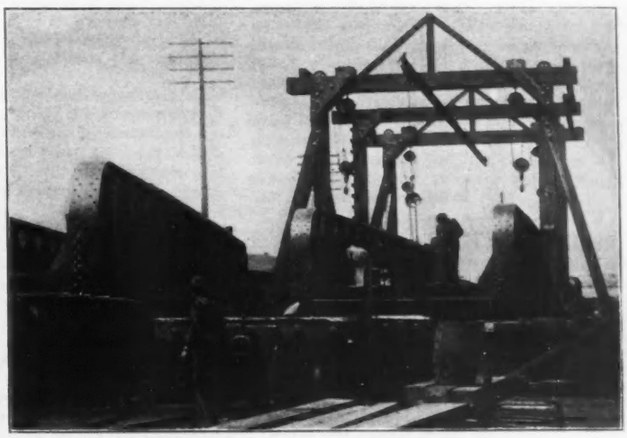
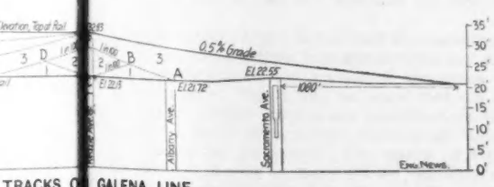


FIG. 4. FRAME FOR ERECTING SUBWAY BRIDGES.



TRACKS O GALENA LINE.

FIG. 7. VIEW SHOWING SUBWAY BRIDGE IN PLACE AND MASONRY NEARLY COMPLETED.

CAGO & NORTHWESTERN RY., CHICAGO.

Soc. C. E., Engineer Track Elevation, Wm. Graham, Engineer of Bridges.

, Chicago, Ill., Contractors for Bridges.

forward by Mr. Merriman, but he has so tersely and ably set forth principles and ideas with which this journal is in hearty accord that we can do no better than cordially commend his address, as admirably setting forth the directions in which progress should be made. We desire, however, to call especial attention to his remarks respecting the tendency toward over-specialization in the engineering schools. He well says that the particular course of engineering study to be pursued by a student is by no means so important a matter as students and the public generally suppose. The young man thoroughly grounded in fundamental principles and well trained in the methods of applying them has almost equal chances of success in all branches of engineering practice.

In our issue of July 30 was published a report of the U. S. Geological Survey on the "Mineral Products of the United States" for the calendar years 1886 to 1895. Mr. David T. Day, Chief of Bureau, now sends us a new chart which, from revised figures of the Director of the Mint, corrects the productions of gold and silver, in 1895, as published in the former chart. To make the corrections plain we publish both the original and corrected figures for 1895, as follows:

	Original.		Corrected.	
Coin'g val.:	Quantity, Troy oz.	Value.	Quantity, Troy oz.	Value.
Silver....	47,000,000	$60,764,300	55,727,000	$72,051,000
Gold.....	2,272,629	47,000,000	2,254,760	46,610,000

WHO SHOULD PREPARE SPECIFICATIONS?

In a letter which we recently received from a well-known engineer the following sentence occurred:

> The preparation of specifications has always been regarded as the function of engineers, who ought to know the character of the work they want, and it is not desirable that this time-honored custom should be changed.

We presume that there are not a few engineers who hold similar views and who regard the formulation of specifications by manufacturers in this or that or the other field of engineering, as in some sense an infringement on the province of the engineer, and a thing to be resented and condemned. It seems worth while, therefore, to discuss the pros and cons of the question, and see just what the attitude of the profession should be on this important matter.

In the first place let us remember not to use the word engineer in too narrow a sense. The manufacturers of to-day are in very many cases able engineers, just as well educated, just as broadly experienced and often more expert in the special line in which they are engaged than is the average engineer who acts as an adviser to those who purchase their products. Take for example the matter of bridges. No one doubts that the chief engineers of the leading bridge companies are among the most able of living experts in this field of engineering. But the average practising engineer does a little in this line and a little in that, and occasionally is placed in charge of a bridge letting. Is it reasonable to expect that he will be so well posted and so expert in the latest and best practice in bridge work that he can draw as good a detailed specification as can be made by the engineer of a bridge company, who is devoting all his time to this one specialty six days out of seven?

Clearly we cannot decree that the manufacturers or the manufacturer's engineer shall not prepare specifications on the ground of ignorance or incompetence. But it may be urged that the manufacturer should not prepare specifications because he will frame them to suit his interests instead of those of the purchaser. The maker of steel, for example, it may be said, will set his limits of sulphur or phosphorus at a point which will suit the ores that he can purchase most advantageously; the paint manufacturer will specify a paint which will carry a goodly amount of cheap adulterants, without transgressing the requirements; the bridge-builder will draw a specification under which poor riveting may be passed, and light sections will be permissible.

Now it would be idle to deny that there is a tendency for the manufacturers to do things of this sort. They must meet keen competition in the markets, and in order to make their prices compare favorably with those of their competitors they must not agree to furnish too good an article. But on the other hand, there are other powerful forces at work to restrain the manufacturer from writing a specification for an article which shall be distinctly inferior with respect to safety, durability, or appearance. If the steel-maker furnishes metal too high in phosphorus, a serious accident may result and the cause may be traced back to his steel. If the paint-maker substitutes cheaper oils for linseed, his customers will complain of his paint as lacking in durability. If the bridge-builder draws a specification by which defective workmanship is made permissible, one of his bridges may fall and the damage to his reputation may injure his business a thousand times as much as the profit that he might make from drawing too liberal a specification.

Clearly, then, the motives which impel the reputable manufacturer to furnish first-class goods to his customers are very strong; and were specifications drawn by this class of manufacturers alone, probably less fault would be found with manufacturers' specifications; but it must be admitted that manufacturers are not all of this class. There are manufacturers who care nothing for the reputation of their goods—who are not working to build up a business but to reap quick profits. There are others whose policy it is to obtain business not by the merit of their products nor their low prices, but by their ability in securing orders from the officers of corporations who are more concerned to line their own pockets than to protect the interests entrusted to them. Clearly, from manufacturers of these latter classes, we can expect nothing excellent, either in products or in specifications describing what the product should be.

Manufacturers, of honesty and reputation, welcome, we believe, invariably, the preparation of specifications by an able and conscientious engineer, because it protects them from the unfair and unequal competition with manufacturers of the classes we have just described. The energetic and honest manufacturer prefers to bid under a strict specification, which defines in every detail what will be required. He can safely make a close bid on work of that sort. But he detests a competition in which a specification of vague platitudes leaves every opportunity open to dishonest competitors to do business according to their methods. Competition of that sort is not competition at all; it is merely a match at wire-pulling.

Now, it is an unfortunate fact that the engineers in charge of works are too often unequal to the task of writing a strict and detailed specification. How often do we see especial emphasis laid in some one feature in a specification, while others of equal or greater importance are left unmentioned. It is also an unfortunate fact that in too many cases important purchases are made of engineering materials without the advice or aid of any engineer. It is surely better where such purchases are made in open competition to have manufacturers' specifications than none at all.

We believe that the most perfect system of preparing specifications and purchasing goods in existence is that which has long been in use by the Motive Power Department of the Pennsylvania Railroad. It has been described before, but we may briefly summarize its chief features. In the first place all the supplies which the great corporation requires, from steel to soap, are bought under strict and detailed specifications. The original draft of these specifications is made by the company's chief technical experts, and copies of this draft are sent to all the manufacturers in that particular line with which the company has any dealings, with a request for criticisms and suggestions. These are all given careful consideration and such are adopted as seem to promise any real improvement. Upon these finally amended specifications all goods are bought. But the process does not stop here, for all specifications are held open to amendment, and are revised from time to time in accordance with increased knowledge or improved processes.

We can imagine no system that could be fairer to all parties concerned, or better calculated to secure for the purchaser an excellent quality of goods at the minimum price consistent with good quality. It may be said that this system is only adapted to the purchase of regular lines of supplies by a great railway corporation; but we believe that many much smaller corporations and many municipal corporations could adopt such a system with profit. There is no reason why a city should not have its standard specifications for bridges, cement, sewer work, paving of various classes, etc., and many cities, indeed, already have them. But the main point on which we desire to lay emphasis is the systematic consideration of the opinions of those who are to work under the specifications—both in their original formulation and in their periodic revision.

Of course, it is true that with all possible use of standard specifications by municipal and private corporations, there still will remain a vast amount of contract work for which special specifications must be drawn if the work is to be properly carried out. We do not urge, by any means, that such specifications had better be made by manufacturers or by contractors; nor do we believe that specifications from this source are likely to be adopted by purchasers to economize in engineering expenses. But we do urge that no prejudice should stand in the way of the acceptance of the points of excellence which may be found in specifications prepared by manufacturers.

It is too little understood by the public generally and too little appreciated even by engineers themselves that the plans and specifications for a structure should actually contain the finished work, and do contain it if they are properly drawn. The actual work should be the mere carrying out of what the engineer has built on paper. Bearing this in mind, the importance of excellent and detailed specifications is easily understood. The real engineer seeks aid in the preparation of his specifications from every possible source. He consults the precedents which the experience of the profession has established, and he will not fail to consider and profit by the experience of those whose province it is to carry out in practice the ideas which he originates.

LETTERS TO THE EDITOR.

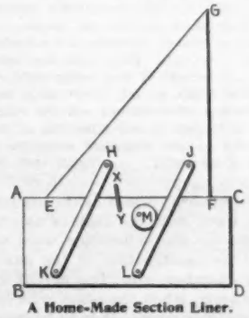
A Blast Which Wouldn't Go.

Sir: In blasting coraline rock I placed a charge of 4 lbs. Hercules No. 2 dynamite in a 7-ft. hole, and set it off with single-ply fuse. The cartridge attached to the fuse fired clean without setting off the charge, I then opened the hole to the charge and placed directly over the charge 2 lbs. more of dynamite which also fired clean without setting the charge off. Will some of your readers explain the cause? Truly,

Miami, Fla., Aug. 9, 1896. Wm. Varnedoe.

A Home-Made Section Liner.

Sir: You will find herewith a drawing of a section liner, which may be easily and cheaply made by any one who is the least "handy." A B C D is the base to which the triangle, E F G, is fastened by the brass connecting pieces, H K and J S. The regulator, M, is a circular piece of brass eccentrically fastened to the base



A Home-Made Section Liner.

and against which the connecting piece, J L, works. X Y is a rubber band to aid in the adjustment, which is easily made by the brass regulator for any width of space from zero to the difference between the two parts of the diameter of the regulator. Very truly yours,

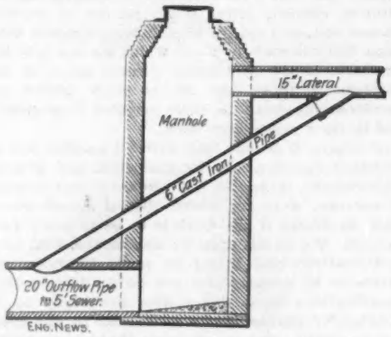
W. D. Sell, Jun. Am. Soc. C. E.

Logan, W. Va., Aug. 1, 1896.

A Problem in Connecting Lateral and Main Sewers.

Sir: In some sewer construction upon which the writer has been engaged recently, a problem arose concerning the solution of which the opinion of other engineers is

desired. A 5-ft. brick sewer was being constructed along a main street to replace a sewer which had been constructed at from 4 ft. to 6 ft. higher level. The laterals from the cross streets had emptied into this old sewer at grade; but when the new sewer was built several feet below the old one, the outlets of these laterals were, of



Proposed Method of Connecting Laterals and Main Sewers, When the Two are at Different Elevations

course, several feet above its grade. The problem was the best method of connecting these laterals with the new sewer. One of the methods suggested is shown by the accompanying cut. The inclined pipe is a dry weather pipe and is of iron. Very truly, B. H. S.

Chicago, Ill., July 17, 1896.

A Question of Professional Ethics.

Sir: On p. 73 of your issue of July 30, 1896, "E. K." would like an opinion on the question of Engineering Ethics. I think he can find his answer in the 2d, 3d and 4th lines of the second column of p. 75.

Respectfully yours, James H. Harlow.

Pittsburg, Pa., Aug. 14, 1896.

(The point raised by "E. K." related to the propriety of the acceptance by an engineer for a department of public parks of the position of chief engineer of a railway to run through the parks. Mr. Harlow refers, in reply, to the following sentence from an address on "The Legal Duties of Engineers and Architects," delivered before the Engineering Association of the South by Hon. Jas. C. Bradford, of Nashville, Tenn.:—Ed.)

One of the commonest rules of the law of principal and agent is, that a man shall not serve two masters.

Fire Tests of Loaded Columns.

Sir: Referring to your editorial in your issue of Aug. 13, on the report of work done by the Committee on Fireproofing Tests, permit me to call your attention to a slight error. The hydraulic apparatus has a capacity considerably in excess of the loads put upon the columns during the tests reported. It is so arranged as to allow the use of a hydraulic pressure of 2,500 lbs. per sq. in., while the greatest testing load was only 1,500 lbs. The loads that were actually put upon the columns represented the maximum limits permitted by the building laws of large and prominent cities.

I also note your suggestions in regard to future work and can state that it is the committee's intention to continue these tests so as to cover the various conditions of practice. Just at present, however, the committee is hampered for want of funds. These tests are very expensive to carry out, on account of their being made on full sized members. The funds so far raised have been entirely through voluntary contributions and the committee proposes at an early date to call a meeting of the Advisory Board, in order to take necessary steps for the further continuation of its work. Yours very truly,

H. de B. Parsons.

(We may add with respect to the matter of funds for further tests, that the bulk of the funds thus far expended by the committee were necessarily devoted to the construction of the gas producer, the testing chamber, etc. The actual expense of making the tests, when the plant was once ready, was comparatively small. It is to be hoped, therefore, that ample funds may be forthcoming to continue these tests on an extensive scale.—Ed.)

The Metric System or Duodecimal Notation?

Sir: Will you allow me to say a few words more upon the question of weights and measures, in reply to your editorial of July 30, which has just reached my eye.

You are right in anticipating considerable delay in making any change in our present system. But it is only a question of time, and therefore not worthy of argument. Some change is inevitable. All are agreed on that; so that, too, is unworthy of argument. Any change which is to be satisfactory must be sweeping, and therefore costly and troublesome beyond estimate. This, also, we may as well accept as inevitable, without wasting time in its discussion.

The only question worthy of the time of clear-sighted men is that of what system is to take the place of the present lack of one. Which one will be the most satisfactory and will cost the least to acquire?

In its discussion, do you not find more satisfactory the frank perspicacity of Mr. Herbert Spencer, in his letter to the "Popular Science Monthly" for July, than the cautious circumlocutions of London "Engineering," that most conservative of all the journals which ever stumbled along twenty years behind the leaders of progressive thought? If the prejudices of the ignorant masses are likely to delay this reform, for which we are so athirst, why add to them the prejudices of the enlightened? It is as futile to discuss the probability of the coming of this inevitable step in progress as to hope to evade the law of gravitation. How may it come most easily is the only topic worthy of paper and printer's ink.

Yours truly, Sidney A. Reeve.

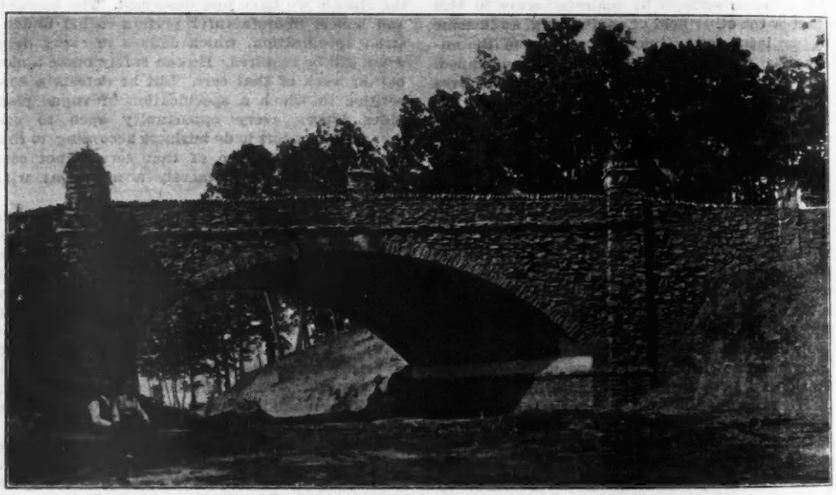
(We are by no means certain that a change is inevitable. It is not likely to be made until there is a popular demand for it, and a change in our system of weights and measures, or in our system of notation, would be certain to encounter popular ridicule and opposition, instead of popular approval.—Ed.)

Notes and Queries.

W. P., Little Rock, Ark., asks for information concerning dump scows for use in dredging material where the depth of water to be secured is only 2 to 3 ft.

A MELAN ARCH WITH ROCK FACING AT ATLANTIC HIGHLANDS, N. J.

We illustrate herewith a handsome masonry arch which has just been erected at Atlantic Highlands, N. J., under direction of the Melan Arch Construction Co., of New York city. The arch is of the well-known Melan construction (steel beams embedded in concrete) and has



MELAN ARCH WITH FIELD STONE FACING AT ATLANTIC HIGHLANDS, N. J.
The Melan Arch Construction Co., New York City, Engineers.

a facing of field stone which gives it an exceedingly picturesque appearance. The arch has a 50-ft. span and has a width of 25 ft. over all, with a 20-ft. roadway. For the Melan construction 6-in. steel beams weighing 13 lbs. per ft. were used, spaced 3 ft. c. to c. Earth filling was placed over the haunches. The road which crosses the arch has a grade of 6% and the arch is built on a skew of 53° 8'.

Atlantic Highlands is a well-known summer resort on the south shore of New York Bay. The borough government contributed $800 toward the cost of the structure and the remainder of the cost was made up by voluntary contributions by public-spirited citizens. Our photograph shows the surroundings of the arch still in an incomplete condition. These will soon be neatly graded and turfed, and ivy will be planted and trained over the arch. The structure is an excellent illustration of the growing tendency toward the choice of designs of aesthetic merit for bridges located in suburban towns and fashionable summer resorts.

THE POOLING OF FREIGHT EQUIPMENT.*

By J. R. Cavanagh.**

There is probably not a road in our association but what at some time during the past few years has seen a period when it has simply been impossible to obtain cars to handle the business offering. These conditions were not caused by lack of equipment in the country, but by the existing methods of handling cars. There are to-day at least 25% more freight cars than are necessary to move the largest volume of traffic we have ever been called on to care for. At no time do we find every section of our vast country in want of some class of cars simultaneously; but under the present system there is no provision for moving the surplus equipment from one section to another.

There are in the United States, Canada and Mexico over 1,175,000 freight cars owned by railway companies, representing an investment of about $580,000,000, which has not for years earned enough to pay the interest on the investment, depreciation and repairs.

The question arises—"What can we do to increase the performance of our cars?"

Plan after plan has been suggested; roads have kept on building cars, but with no apparent relief. The only remedy is the general pooling of all freight cars, the adoption of the per diem system, a uniform standard in sizes of cars, and the full enforcement of car service.

Referring to the proceedings of the Eastern railway car service officers in September, 1894, we find the following resolution:

Resolved, That a general distributing office or clearing house, with subsidiary bureaus, be established for the purpose of regulating and increasing the supply of cars between railways to meet the legitimate demands of traffic.

I believe that the time is not far distant when we have got to come to a general distributing office, or something of the kind. A few contend that it is "too large a subject," "too many conflicting interests to harmonize," etc. The same remarks were made by many of our most prominent railway men when the Joint Traffic Association was suggested, but it came, is here, and apparently to stay.

There has been too much selfishness in the past which has resulted in disaster to the majority. We must unite now on some plan that will stop the enormous leaks caused by:

1. Idle equipment in one part of the country while another part is suffering for want of the same identical cars.

2. The handling of empty cars of similar class in contrary directions on account of route or initials.

3. The switching of empties out of sidings, freight houses, etc., only to switch in the same class of cars to load via lines other than those owning the cars switched out.

4. Unnecessary switching to get some particular car out of a string of empties, when the first car is exactly the same kind of a car but with other initials.

*A paper read before the Association of Railway Officials at Toledo, O., July 21, 1896.

**Superintendent of Car Service, C., C., C. & St. L. Ry., Indianapolis, Ind.

5. The expense of traveling car agents, car tracing clerks and car service associations. (The latter will be merged into district bureaus.)

As an illustration, take the sleeping car companies. Were all contracts to be annulled to-morrow between them and the railway companies, twice the number of sleeping cars now in service would not care for the current business, making no provision for equipment needed during large conventions, gatherings, etc.

Take the private stock car companies. No railway company can show up any such average mileage per car per day. While railway companies average 35 to 50 miles, the private car companies run 75 to 100. You see a string of their cars in Montana to-day, at the seaboard in a few days, and a week later away down in Texas or Mexico. Their cars are always in active service because handled by one central authority to meet the requirements of the various sections.

In forming a car pool or equipment company I would recommend that we start in with the box cars first, because that class of cars is in more general demand and in 90% of the cases represents the item of equipment from which we receive most complaints of shortage.

With a view of economy in painting, clerical work, car recording, accounting, etc., I would recommend something after the following plan:

1. Have a distinctive mark to represent the class of car, thus:

"A," for box cars; "B," stable stock cars; "C," common stock cars, single deck, etc.

Abolish all car initials and use the distinctive letters instead.

Each kind would commence at 1 and number up, thus: A box car 34 ft. long (inside) 60,000 lbs. capacity, would simply be marked "A D E," 5,910. In a short time every switchman, bill clerk, auditor's clerk, car distributor, record clerk and employe or shipper would know at a glance what a car was. There would be no necessity of consulting a guide. Instead of reporting a dozen or more initials on car reports, we would simply use the "pool" marks. In many cases this would reduce the number of initials to report over 70%.

Of box cars alone the Guide shows that there are over 630,000, at an approximate valuation of over $310,000,000, and distributed as to lengths as follows:

20 ft. long	275	36 ft. long			15,057
22 " "	33	37 " "			2,393
23 " "	84	38 " "			1,739
24 " "	995	39 " "			957
25 " "	478	40 " "			5,157
26 " "	514	41 " "			150
27 " "	36,615	42 " "			158
28 " "	97,668	44 " "			15
29 " "	39,658	45 " "			31
30 " "	54,743	46 " "			55
31 " "	1,338	47 " "			2
32 " "	30,242	49 " "			2
33 " "	134,311	52 " "			14
34 " "	200,533				
35 " "	7,079				630,176

The first step necessary to form a pool (after the roads have agreed to it) is the establishment of a general or central office in charge of a general manager. Then divide the country into districts, similar to or in conformity with the freight traffic associations, such as eastern, central, etc., each district to be in charge of a district manager or distributor; each road to handle its own distribution as at present; daily reports to be rendered to the district office, which, in turn, consolidates and transmits the same to the central office.

The pool would have to be organized by each road taking as much stock in the equipment company as the valuation of its equipment amounted to, each company to receive its pro-rata earnings as each class of cars it owns in the pool bears to the total number of cars or valuation of that class: Thus all 34 ft. box cars, 50,000 capacity would be marked "A D D." If the L. S. & M. S. Ry. owns 11% of the valuation of all cars in that class, it would receive 11% of the earnings.

If such a thing is necessary the identity of the cars can be preserved by assigning each road's cars of the same class into consecutive series or numbers: Thus, C., C., C. & St. L. Ry., 34 ft., 30 ton box cars 18,000 to 18,999 would be assigned "A D E" 1 to "A D E" 1,000; N. Y. C. & H. R., 52,000 to 55,999 would be assigned "A D E" 1,001 to "A D E" 5,000, etc.

Each road in the pool will be entitled to the same number of cars in each class as it owns in the pool, providing it needs them, and must accept up to its quota when offered for storage.

Compensation should be based on both the earning capacity of car and per diem, if possible. Thus:

30 ton and over, per diem 30 cts., or ⅝ ct. per mile.
25 ton and over, per diem 25 cts., or ½ ct. per mile.
20 ton and over, per diem 20 cts. or ⅜ ct. per mile.
15 ton and over, per diem 15 cts. or ¼ ct. per mile.
Under 15 tons, per diem 10 cts., or ⅛ ct. per mile.
For all cars in excess of 39 ft. add an agreed per cent.

By graduated compensation as suggested above, in addition to the justness of the proposition, roads would use only such cars as are necessary to handle the business. Thus, a road that could use ¼ ct. cars would not call for ⅝ ct. cars, allowing the latter to go into such service as the ¼ ct. equipment would be incapable of handling.

Car repairs could be based on proportion of mileage or per diem, or on such basis as may be agreed upon by the Master Car Builders of lines interested. This means uniform standards sooner than under present methods.

The car pool means decreased expenses from

1. The increased performance of all cars, permitting the handling of a given quantity of business with a minimum number of cars—obviating the building of any new equipment for five or six years.
2. Decrease in empty and foreign mileage.
3. Saving in switching at terminals and stations.
4. Reduction in train mileage.
5. Decrease in inspectors, repair shops, material, maintenance of way, car repairs, wheelage or trackage over foreign rails, clerical work, telegraphing, etc.
6. Increased earnings from greater supply of cars and reduction in expenses.

The district manager for the Joint Equipment Association would have charge of distribution of equipment, handling of demurrage or car service matters, car repairs and all matters pertaining to the equipment. This would be an improvement over present methods, for the reason that the car owner would have a representative at every point seeing that the best service was gotten out of the equipment, while under present conditions at many points foreign equipment is abused, misused and held on account of being a "wanderer from home."

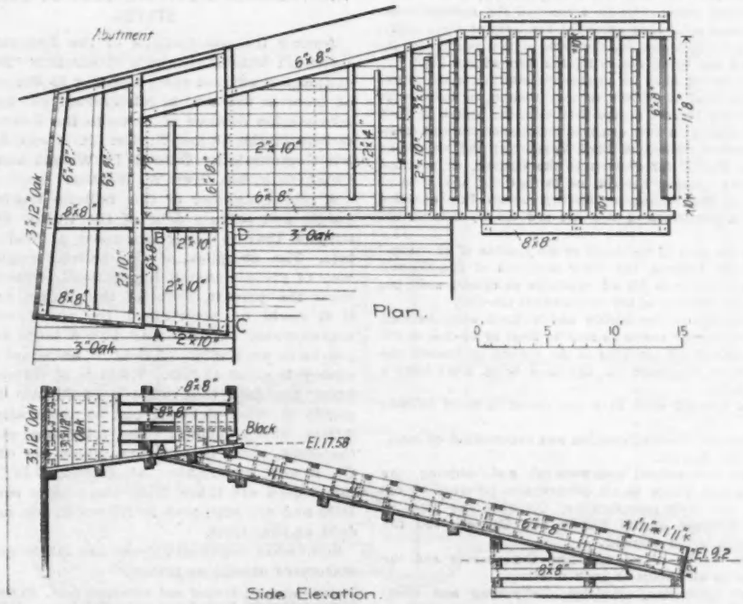
After the box cars have got to working in the pool, then add stock or other classes as fast as considered advisable or as the trustees representing the owners may decide.

The difficulties to be overcome are not as great as might appear upon first consideration of the subject, as an organization can be formed by which all roads desiring to become members (stockholders) would be protected equitably in their rights.

Last fall I took the trouble to inquire about the probable loss to railways from cars lying idle at junction points, switching, etc. Replies were received from a number of representative men. The lowest estimate showed from loss of revenue, cost of transfer, and loss in car mileage for one year over $25,000,000, and the above simply on account of owners not allowing their cars to go beyond junction point.

FISHWAY FOR DAM AT STERLING, ILL.

We illustrate herewith a fishway built in the dam of the Sterling Hydraulic Co., at Sterling, Ill., under the direction of Mr. L. L. Wheeler, M. Am. Soc. C. E., to whom we are indebted for the blue print from which our illustration has been prepared.



FISHWAY IN DAM AT STERLING, ILL.
Designed by L. L. Wheeler, C. E.

Mr. Wheeler states that the plans furnished in response to his application to the U. S. Fish Commission and the Illinois Fish Commission did not appear to be adapted to the conditions he had to meet or likely to be satisfactory if followed. The form and dimensions of the cribs and fishway were in part fixed by local conditions, and they were built from remnants left from repairing the dam. The cribs were packed with stone, except over the upper end of the fishway. The timbers A C and B D are simply blocked on the crest of the dam, leaving the water free to spill over the crest C D. The openings A B are of equal size, and it is intended that the head on the opening B shall be practically constant. The minimum distance the water travels in overcoming a fall of 8.4 ft. is 200 ft.

CIVIL ENGINEERING A CLOSE PROFESSION IN MANITOBA.

It is probably not known to many of our readers that civil engineering is now a close profession in the province of Manitoba, Canada, and that the indiscriminate use of the title of "civil engineer" or "C. E." is illegal, as is also the practice of engineering by any but a member of a national association of engineers.

We have from time to time recorded the steps taken and the progress made by the Canadian Society of Civil Engineers in its movement to secure legislation making the society a close corporation, and the matter was editorially discussed in our issue of April 30, 1896. At the last annual meeting it was voted that the council should appoint a committee of three in each province to see if the government of the province would pass the proposed bill to limit the practice of civil engineering to members of the Canadian Society of Civil Engineers. In Manitoba the matter was acted on very promptly, and the bill was at once submitted to and passed by the government of that province, which has thus the distinction of being the first government in the world to make engineering a close profession. It may be noted that in all the Canadian provinces the practice of surveying has been limited by law to surveyors who have passed the government examination, while in some (including Manitoba) only members of the provincial society of surveyors are authorized to make surveys.

We are indebted to Mr. H. N. Ruttan, M. Am. Soc. C. E., City Engineer of Winnipeg, Man., for a copy of this law, and we reprint it herewith in full. The principal feature of the bill is contained in the last paragraph, and we have briefly commented upon it in another column.

An Act respecting the Profession of Civil Engineers.
(Assented to 19th March, 1896.)

Whereas, it is deemed expedient for the better protection of the public interests and for the general advancement of Mechanical Science, and more particularly for promoting the acquisition of that species of knowledge which has special reference to the profession of a Civil Engineer, and to encourage investigation in connection with all branches of knowledge connected with the profession, and in order to enable persons requiring professional aid in any work, to which such knowledge of Civil Engineering is applicable or necessary, to distinguish between qualified and unqualified Civil Engineers;

Therefore,

Her Majesty, by and with the advice and consent of the Legislative Assembly of the Province of Manitoba, enacts as follows:

1. This Act may be cited as "The Manitoba Civil Engineers Act."

2. The Civil Engineers of Canada, heretofore incorporated by an Act of the Parliament of Canada, being Chapter 124 of the Acts passed at the Session held in the 50th and 51st years of Her Majesty's reign, under the name and style of "The Canadian Society of Civil Engineers," shall be a body corporate by the name aforesaid, having perpetual succession and a common seal, with power to acquire, hold and dispose of real and personal property for the purposes of its constitution, and to sue and to be sued in the manner usual with such corporations.

3. All persons who, on the day this Act comes into force, are members of the said existing Canadian Society of Civil Engineers, and all persons who shall hereafter be admitted as members of the Society hereby incorporated, and who shall be registered under the provisions of this Act, shall be members of the said Society.

4. There shall be a Council of Management of the said Society, to be appointed in the manner provided for in this Act, and hereinafter referred to as "the Council."

5. The Council shall be composed of twenty-one persons, who shall, in the first instance, and as a Provisional Council, consist of the present Council of the existing Canadian Society of Civil Engineers, if British subjects and residing within the Dominion of Canada.

6. The members of the said Provisional Council shall meet in the City of Winnipeg for the purpose of organization, within two months after the passing of this Act, at such time and place as may be set forth in a notice in the Manitoba Gazette, and at such meeting any five members of the Council shall form a quorum.

7. A general meeting of the members of the Society shall be called by the Provisional Council, on or before the First day of February next after the passing of this Act, for the election of a permanent Council. The time and place for such meeting shall be determined by the Provisional Council, and at least two weeks' notice in writing shall be given by the Secretary to each member of the Society, and such meeting and any subsequent meeting of the Society may be held without this Province, but in the Dominion of Canada, as the Council may from time to time determine.

8. All members of the permanent Council shall be elected by ballot, each member having one vote, and the member or members obtaining the greatest number of votes shall be declared elected.

9. The members of the Council so elected shall hold office for the following terms respectively:

The seven names who have received the greatest number of votes shall hold office for the term of three years, the next seven names for the term of two years, and the third and last seven names for the term of one year.

10. No person shall be eligible for election to the Council, or qualified to fill any vacancy therein, or to vote for any member thereof at the first election, unless at such time he shall be a duly qualified member of the said existing Canadian Society of Civil Engineers; and no person shall be eligible for election to the Council, or qualified to fill any vacancy therein, or to vote for any member thereof at any subsequent election unless duly qualified under the provisions of this Act and the By-laws of the Society.

11. In the case of the death or resignation of any members of the Council, the other members of the Council shall have power to fill all vacancies so caused until the time of the holding of the next annual meeting.

12. Meetings of the Society and Council shall be held at such times and places as may be fixed by by-law of the Society, and at all meetings of the Society or Council the President or Chairman for the time being shall have a casting vote.

13. The Council shall have full power to enact by-laws for:

(a.) The qualification, election and registration of members of the Society.

(b.) The appointment and removal and defining the functions and duties of all officers and servants of the Society, and their remuneration, the time and place of holding meetings of the Society and Council, and the notice to be given therefor.

(c.) The calling of all meetings, the quorum and the procedure in all things at such meetings.

(d.) The suspension, expulsion, disciplining and readmission of members.

(e.) The appointment of examiners for the purpose of ascertining and reporting upon the qualifications of persons who shall present themselves for admission and enrolment as students at any examination.

(f.) The admission and regulation of students, the periods and conditions of study, and all matters relating to the discipline and honor of the profession.

(g.) The regulating and fixing of the admission and annual fees payable by members and students. And to deal with and regulate all other matters necessary for the government of the Society, and to effectually carry out its objects, and generally to administer the affairs of the Society.

14. The Council may from time to time repeal, amend and re-enact the by-laws of the Society; but every such by-law and every repeal, amendment and re-enactment thereof, unless in the meantime confirmed at a General Meeting of the Society, duly called for that purpose, shall only have force until the next Annual Meeting of the Society, and in default of confirmation thereat, shall, at and from that time only, cease to have force, and in that case no new by-law to the same or like effect shall have any force until confirmation at a General Meeting of the Society.

15. The Council shall cause to be kept by an officer appointed by it, to be called the Registrar, a book or register, in which shall be entered the name of every person registered as a member of the Society, according to the provisions of this Act, and those persons only whose names are inscribed in the book or register above mentioned shall be deemed to be members of the Society, and such book or register shall at all reasonable times be open for inspection by any member of the Society or by any other person.

16. If the Registrar shall wilfully make or cause to be made any falsification in any matter relating to the register, or shall refuse to allow the register to be inspected, he shall be deemed to be guilty of a misdemeanor, and shall on conviction thereof be imprisoned for any term not exceeding twelve months.

17. On and after the 1st day of July, 1896, no person shall be entitled within this Province to take or use the name and title of "Civil Engineer" or any abbreviation thereof, either alone or in combination with any other word or words, or any name, title or description implying that he is a member of the said Society of Civil Engineers, or act as Engineer in laying out, advising on, constructing or superintending the construction of any railway or public work, or any work upon which public money is expended, the cost of which shall exceed $500, unless such person is a member of the Society hereby incorporated and registered as such under the provisions of this Act, or unless he is a duly qualified Civil Engineer, and entitled to use the title of Civil Engineer by virtue of some statute in force in this Province, or by the authority of some institution of learning in this Province having authority to confer degrees in Civil Engineering, or unless he has been practising as a Civil Engineer in this Province at the time of the passing of this Act, or unless he is a member in good standing of some institution of Civil Engineers in Great Britain and Ireland, or of some National Society of Civil Engineers of good standing in any foreign country.

18. This Act shall be deemed a Public Act.

THE PUBLIC AND PRIVATE DEBT OF THE UNITED STATES.

Among the publications of the Department of Labor at Washington is a bi-monthly "Bulletin," containing current facts relating to the condition of labor in this and in other countries, and other information deemed of value to the industrial interests of the United States. It is edited by Labor Commissioner Carroll D. Wright and by his Chief Clerk, Mr. Oren W. Weaver.

A recent number of this bulletin treats of the public and private debt of the United States; a subject that is being discussed a good deal of late. The compiler of the bulletin explains by way of preface that it is practically impossible to show the private debts of the people, and even if it could be ascertained the result would be meaningless. A man may owe a large sum and yet have no burden of debt if an equal sum of money is owed to him. What is of interest is to know the debt that must be paid, not by payments of other debtors, but by the fruits of industry and economy. The following statistics, therefore, show these debts, which are offset little, if any, by credits. All except 12.14% of the items used are taken from the census returns of 1890 and are supposed to represent the minimum debt at that time.

Somewhat condensed from the tables given the statement stands as follows:

Steam railways, funded and unfunded debt.		$5,069,431,114
Street railways, funded and unfunded debt.		*182,240,754
Quasi public corporations:		
Telephone companies	$4,992,565	
Telegraph companies	20,000,000	
Public water companies,**	80,127,489	
Gas companies	75,000,000	
Electric light and power	5,000,000	
Transportation companies, not otherwise specified, canals, turnpikes, bridges, etc.	114,208,078	
		348,328,132
Total		$6,200,000,000
Real estate mortgages		$6,019,679,985
Crop liens (estimated)		650,000,000
National banks, loans and overdrafts		1,904,167,351
Other banks, loans and overdrafts		1,172,918,415
National, State and local taxes		1,040,473,013
Other private debts (estimated)		1,212,761,236
Aggregate private debt		$18,200,000,000
Public debt, less sinking fund:		
United States	$891,960,104	
States	228,997,389	
Counties	145,048,945	
Municipalities	724,463,060	
School districts	36,701,948	
		2,027,170,546
Aggregate private and public debt		$20,227,170,546

*By table published in our issue of July 6, this item is now about $600,000,000.
**Not owned by cities.

In the above the debts of individuals and private corporations amount to 59.88% of the total, and quasi-public corporations form 30.05%. The real estate mortgage debt alone is 29.76% of the total, and the railway companies follow with 28.03%. The public debt of the United States forms 4.41% of the total as compared with 9.58% for municipalities. The author places the wealth of the United States, in 1890, at $65,037,091,197; so that the total private and public debt represents 31.10% of the total wealth of the country. The per capita private debt, in 1890, was $291, and public debt $32, an aggregate of $323, or $15.94 per family of 4.93 persons. The real estate mortgage debt is $6,019,679,985; while the estimated value of taxed real estate and untaxed mines was $36,025,071,490.

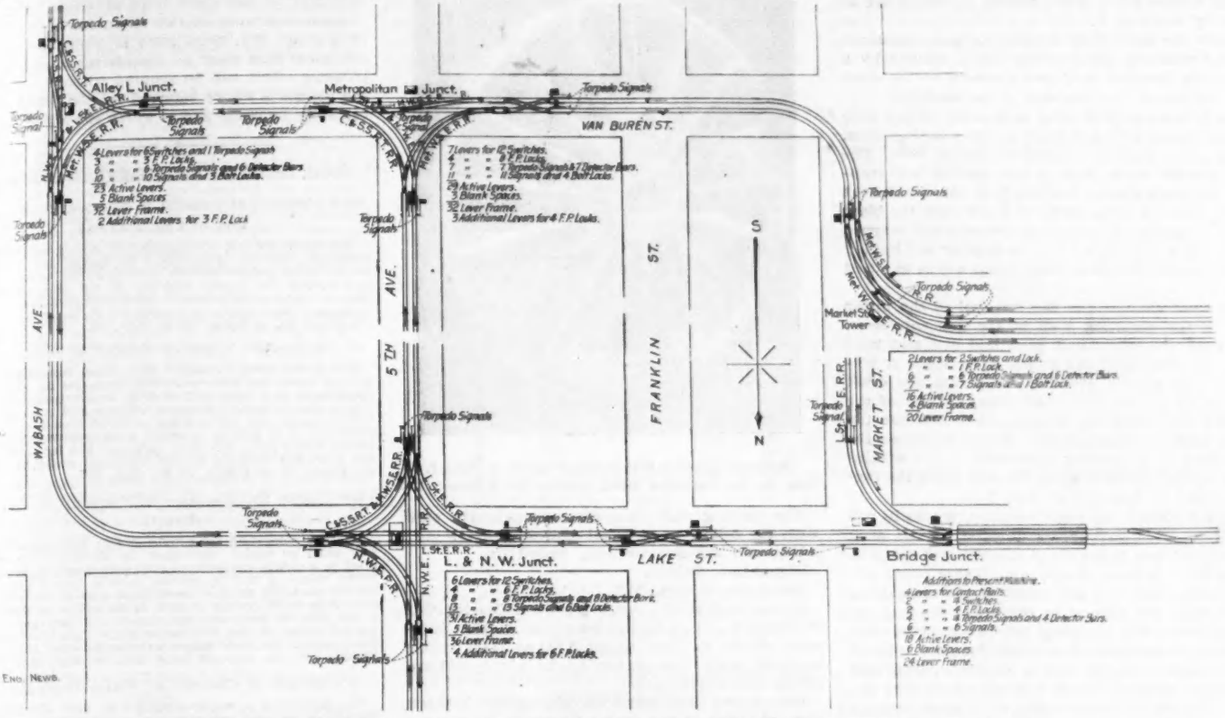
SIGNAL AND INTERLOCKING PLANT FOR A LOOP TERMINAL AT CHICAGO; UNION ELEVATED RAILWAY.

The city of Chicago has now a number of elevated railways extending in all directions from the central part of the city, and work is now in progress on a loop terminal system which will connect the several lines, and enable them to land passengers in the heart of the business district, as described and illustrated in our issue of July 16. This line is being built by the Union Elevated Ry. Co., which has been formed by representatives of the Chicago & South Side Elevated Ry. Co. (Alley Line), the Metropolitan West Side Elevated Ry. Co., the Lake Street Elevated Ry. Co., and the North Side Elevated Ry. Co. The first three lines are in operation, and the fourth is preparing to build a line northward from Lake St. This loop line will be a double-track line, with junctions at Wabash Ave. and Van Buren St., Fifth Ave. and Van Buren St., and Lake and Van Buren Sts., together with the necessary connecting tracks, crossovers, etc. In addition to these three junctions, the four-track line of the Metropolitan Elevated Ry., which now ends at Franklin St., will be changed so as to carry traffic south on Market St. to Van Buren St., and the present interlocking plant at Bridge Junction will be enlarged so as to operate the double crossover at Franklin and Lake Sts. These junctions are indicated in the accompanying plan, which also shows the location of all switches and signals.

The volume of traffic which will be put upon the loop line will, it is said, probably exceed that of any railway now operated. The number of trains now on the three railways in operation is not less than 1,000 per day, and with the addition of trains from the North Side railway this traffic will probably not be less than 1,500 trains per day. On the three lines now in operation the trains are run on the right hand track, and in order that the traffic may be divided on the loop it has been decided to operate this loop left handed, the outer track being used by the North Side and the Lake St. lines, and the inner track by the Metropolitan and South Side lines. By following the current of traffic on the several lines, as indicated by the arrows on the plan, it will be seen that the crossings at the several points will necessitate the installation of a very complete system of signaling and interlocking in order that the maximum of safety may be secured with the minimum of delay in the manipulation of traffic.

All switches will be considered as facing point switches and will be equipped accordingly, and since it is not feasible on an elevated structure to provide any physical protection in the shape of a derail or scotch block, the torpedo machine will be installed and operated in the same manner as a derail and each signal will be operated in conjunction with this torpedo signal, all torpedo signals having separate levers, and connections from them operating the signal. The introduction of this audible signal will

undoubtedly prove of great value in the operation of traffic over this complicated system of tracks, as it gives immediate notice not only to the engineman but to all train hands when the first pair of


Torpedo Signals
Alley L. Junct.
Metropolitan West Side Elevated R.R.
Metropolitan Junct.
VAN BUREN ST.
C. & S. S. R.R.
N.W.E.R.R.
4 Levers for 6 Switches and 1 Torpedo Signals
3 " " 5 F.P. Locks.
6 " " 6 Torpedo Signals and 6 Detector Bars.
10 " " 10 Signals and 3 Bolt Locks.
29 Active Levers.
5 Blank Spaces.
32 Lever Frame.
2 Additional Levers for 3 F.P. Lock
7 Levers for 12 Switches.
4 " " 8 F.P. Locks.
7 " " 7 Torpedo Signals & 7 Detector Bars.
11 " " 11 Signals and 4 Bolt Locks.
29 Active Levers.
3 Blank Spaces.
32 Lever Frame.
3 Additional Levers for 4 F.P. Locks.
AVE.
WABASH
5TH
FRANKLIN ST.
S
N
Market St. Tower
MARKET ST.
L.S.E.R.R.
2 Levers for 2 Switches and Lock.
1 " " 1 F.P. Lock.
6 " " 6 Torpedo Signals and 6 Detector Bars.
7 " " 7 Signals and 1 Bolt Lock.
16 Active Levers.
4 Blank Spaces.
20 Lever Frame.
CASSIDY JUNCT.
L. & N. W. Junct.
LAKE ST.
Bridge Junct.
6 Levers for 12 Switches.
4 " " 6 F.P. Locks.
18 " " 6 Torpedo Signals and 8 Detector Bars.
13 " " 13 Signals and 6 Bolt Locks.
31 Active Levers.
5 Blank Spaces.
36 Lever Frame.
4 Additional Levers for 6 F.P. Locks.
Additions to Present Plant.
4 Levers for Contact Rails.
2 " " 4 Switches.
2 " " 4 F.P. Locks.
4 " " 4 Torpedo Signals and 4 Detector Bars.
6 " " 6 Signals.
18 Active Levers.
6 Blank Spaces.
24 Lever Frame.
ENG. NEWS.

SIGNAL AND INTERLOCKING PLANT FOR THE LOOP TERMINAL OF THE UNION ELEVATED RY. CO., CHICAGO.
National Switch & Signal Co., Easton, Pa., Engineers and Contractors.

wheels has passed a home signal set at danger. Each torpedo machine is equipped with a certain number of detonators, and since the operator in charge of the plant is required to keep a complete record of the detonators delivered to him it is not likely that he will allow an engineman to pass a signal at danger and explode a detonator without making a full report to the proper officer. At the same time, as the engineman knows that such a report will be filed against him for disobeyance of signals, he will not be likely to pass a signal at danger.

The machine at Fifth Ave. and Lake St. will be located in a tower spanning the tracks and will have 40 levers; the machine at Wabash and Van Buren Sts. will be placed in a tower on the deck of the bridge and will contain 32 levers; the machine at Van Buren St. and Fifth Ave. will be located in a tower south of the south track and will contain 36 levers; the machine at Market and Franklin Sts. will be located in a tower between the lines of Franklin St. and will contain 20 levers; the additions to the present plant at Bridge Junction will involve 24 levers. All the signal towers will be of fireproof construction, and completely equipped with modern plumbing, heating and telephone connections. The machines will be carried on steel frames.

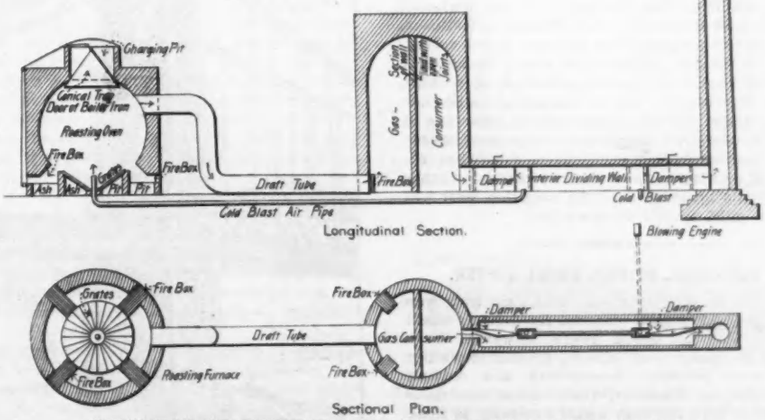
The operation of traffic around the loop will be entirely in the hands of the Union Elevated Ry., and as soon as a train from either of the four lines operated on the loop enters the limits of interlocking all trainmen will be under the orders of the officers of the loop. It is expected that work will be commenced at once at Bridge Junction and Van Buren St. and Fifth Ave., and be pushed to completion as soon as the structure is built on Van Buren St. The motive power to be used on the loop will be electricity, operated in the same way as on the Metropolitan West Side Ry., there being a third rail carrying the current which is supplied to the motor through a contact shoe which runs on this rail.

The contract for planning the entire system, and for designing and installing all the work, has been given to the National Switch & Signal Co., of Easton, Pa.; and the company was instructed by Mr. D. H. Louderbach, General Manager of the Union Elevated Ry., to present the most complete plans necessary for the safe and convenient handling of the traffic, without regard to cost of installation.

THE GARBAGE CREMATORY AT PORTLAND, ORE.*

By A. McL. Hawks, Jun. Am. Soc. C. E.

The garbage crematory owned and operated by the city of Portland, Ore., is situated on the west bank of the Willamette River at a point about 15 miles lower down than the city, where access is convenient to steamboats and scows.



SKETCH PLAN AND SECTION OF GARBAGE CREMATORY AT PORTLAND, ORE.

The building is a shed-like structure covering the furnaces, which are shown by the accompanying sketch, with a square stack 70 ft. high at the rear. The wharf, or landing, is two stories high, the lower story at the level of the furnaces and the upper at the level of the top of the main or roasting furnace.

The plant consists of a brick roasting furnace, the opening and between the four fire-boxes. On the side of the oven, well up towards the opening, is a 4-ft. circular draft tube of steel leading to the second or "gas consuming" furnace.

This secondary furnace is also of brick and circular in form, and is of a little greater height than the first or roasting furnace. The interior is cylindrical with a hemispherical dome at the top, and is divided in halves by a brick wall, the part included in the dome being laid with joints open very wide. On the side of the partition wall near-

oven; and to close this aperture is a conical bell of boiler iron hung by a chain over a pulley. At the bottom is a tuyere whereby a strong blast is brought into the oven at a point directly below

*Information collected by Mr. Hawks for Mr. Rudolph Hering, M. Am. Soc. C. E., and published with the consent of Mr. Hering.

est the roasting furnace are two auxiliary fire-boxes, one on each side of the draft tube for the purpose of assisting in burning the gases as they come over from the roaster. Later on the upper part of the partition wall was entirely removed, as it hindered the draft almost to the point of entirely stopping it.

From the secondary furnace, or gas consumer, a long chamber leads to the stack, divided by a fire brick partition wall and dampers so the draft may be turned to either side of the chamber.

There is a small blowing engine for the purpose of furnishing a forced draft to the roasting oven.

The plant was constructed in March, 1894. The first change made was in the conical bell trap-door of the roaster. Subjected to the great heat of the roasting oven, with the draft from the blast directly against it, it soon overheated and warped badly. It was replaced with a heavier one having a cast rim at the lower edge, which seems to stand well.

The next change was the removal of the upper part of the partition wall in the gas consumer. Although the joints had been laid dry and very wide open, the soot and grease soon began to collect in the narrow crevices, hindering the draft to such an extent that finally the capacity of the furnace fell below the requirements, and the top of the wall was taken down. Before that time the plant had been entirely successful in the attainment of the objects sought. No odor from the furnace could be detected at that time.

When I visited the plant recently, it was in full operation. The garbage is dumped at the dock in Portland into boxes about the size and shape of the body of a large dump cart. These boxes are taken, on a scow, to the wharf of the crematory, where they are hoisted to the upper landing directly beside the charging pit. At intervals determined by the condition of the furnace, this pit is filled and then the bell is lowered, permitting the load to slide off evenly distributed all over the oven. The size of the charging pit is great enough to permit whole animals to be passed through.

On the leeward side of the furnace there was a distinct odor which could be observed over a fan-like area having the stack for a centre and being 200 to 300 ft. wide at a distance of 500 or 600 ft. Beyond that distance it was so faint that it could not be determined. On breezy days it is said to be observable at 1,000 ft. distant. As the crematory is removed from any settlement, and no houses are near, there has been no complaint. The fires in the furnaces are continuous and the plant consumed 35 tons of garbage per day, using two to three cords of wood in the fire-boxes for aiding in the cremation. Five men are employed.

The ash from the roasting oven is perfectly odorless and inert. It can be sold as a fertilizer, bringing $10 per ton. The garbage is not sorted, so this is the only source of revenue. No account has been kept whereby the reduction of weights can be ascertained; the opinion seems to be that it takes about ten tons of garbage to make one of ash. The odor from the stack in its present operation is not exceedingly offensive, somewhat resembling cooking ham. If the city makes no other change it is probable that the partition wall will be again built up in a modified form.

A CAST-STEEL DRIVING WHEEL CENTER.

It is not so very long ago that cast iron was deemed a good enough material for driving wheel centers. The last dozen years, however, have brought increased train speeds, greater loads per wheel, more powerful locomotives, and driving wheels of larger diameter. Under these conditions it is found that the best metal available is none too good for driving wheel centers, and the best quality of cast steel is now extensively used for this purpose.

The accompanying cut shows what remarkably tough and ductile material is now obtainable in cast steel, and also that the steel founder does not hesitate nowadays to undertake castings of complicated form. The casting shown is a driving wheel center 72 ins. in diameter for a 78-in. driving wheel. The axle is 8½ ins. in diameter and the crank-pin is 5½ ins.. The total weight of the casting is 2,795 lbs., which is, we understand, about 500 to 700 lbs. less than the weights of cast-iron centers of the same diameter.

Cast-Steel Driving Wheel Center for 78-in. Wheel. Made by the American Steel Casting Co., Thurlow, Pa.

The casting was made from open-hearth steel with the following physical characteristics:

Ultimate tensile strength, 68,500 lbs.
Elongation, 28.50%.
Reduction of area, 47%.

It was cast by the American Steel Casting Co., of Thurlow, Pa., and the managers of that company inform us that about 2,500 to 3,000 wheels equipped with these centers are in service and are giving entire satisfaction.

The casting from which our photograph is taken was exhibited at the recent Saratoga convention of the Master Mechanics' Association.

THE TOWERS FOR THE NEW EAST RIVER BRIDGE.

As the result of some criticism upon the general design of the New East River Bridge, from an aesthetical point of view, and of an effort to associate a competent architect with the civil engineer in this design, Chief Engineer L. L. Buck submits the accompanying perspective view of the tower as designed by him.

Perspective View of Towers Designed for the New East River Bridge.

From a purely structural standpoint this design doubtless answers every requirement; and in criticising the design the elements of mass and height must not be neglected. We are utterly opposed to false ornamentation in similar structures and to any attempt to disguise the real materials of construction or the chief lines of stress. But in a monumental work of this character, in the center of a great city, good taste in design and proper ornamentation must be considered; and if a more pleasing effect can be secured without sacrificing the elements above referred to, the effort should certainly be made and is worth the added cost.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

When Municipal Consent is Necessary for Operation of City Railway

Municipal consent is requisite to enable any railroad company, whether incorporated by special act of assembly or under general railway laws of a state, to enter upon and occupy the public highway of the city, unless its charter contains authority for same in express terms or by necessary implication.—Philadelphia v. River Front Ry. Co. (Supr. Ct. of Penn.) 34 At. Rep., 60.

Injunction Against Water Company.

Where the water furnished by a water company, incorporated under the laws of Pennsylvania, for the use of the inhabitants of a town in that state, is utterly unfit for domestic use, or use by domestic animals, and is so destructive to pipes and boiler flues as to be unsafe for steam purposes, it is proper to enjoin such company from collecting water rents for other purposes than for extinguishing fires and flushing sewers.—Brymer v. Butler Water Co. (Supr. Ct. of Penn.), 33 At. Rep., 707.

City Liable for Damage to Property in Grading Streets.

Under a constitutional provision that no person's property shall be taken, "damaged" or destroyed for or applied to a public use without adequate compensation being made, where a city in grading streets, leaves large and dangerous holes in the streets, and also in the abutting lots, it is liable to the owners of such lots for damages, if any, to the lots; and the measure of damages is the market value of the lots immediately before and immediately after the excavations were made.—San Antonio v. Mullaly (Ct. Civ. App. of Tex.), 33 S. W. Rep., 256.

Forfeiture of Charter of Water Companies.

The failure of a water company to elect directors or officers, or to hold any meetings, or to perform any corporate act, for many years, and an attempt to sell and surrender all its property to another corporation, is a wilful violation of corporate duties, entitling the state to demand a forfeiture of its charter. The fact that another company is furnishing the people with water, as the pretended successor to such company, will not deprive the state of the right to demand a forfeiture.—City Water Co. v. State (Ct. Civ. App. of Tex.), 33 S. W. Rep., 250.

Street Railway Liable for Entire Street Paving.

The charter of a street-car company provided that it should be compelled to keep in constant repair that portion of the street which it uses and occupies and be subject to such ordinances of the city council as relate thereto; and the city ordinances provided that all street car companies should be at the entire cost and expense of maintaining, paving and repairing that may be necessary on any street occupied by them. The Supreme Court of Pennsylvania held that such company was bound to keep in repair not only the portion of the street occupied by them, but the whole street from curb to curb.—Philadelphia v. Passenger Ry. Co., 33 At. Rep., 126.

Liability of Director of Mining Corporation.

The law of California declares it the duty of the mine superintendent to file weekly and monthly accounts and reports, verified under oath, showing receipts, disbursements, number of employees, and wages paid, reports to be kept in the office of the company, open to inspection of the stockholders. It further provides that in case of the failure of the directors to have the reports and accounts made and posted as provided, an action shall be liable by any stockholder, who, on proof of the failure, shall recover judgment for $1,000 liquidated damages. The Supreme Court of that state held that the statute being remedial, and there being no ambiguity in it, recovery could be had of the directors for failure to have the accounts and reports of the superintendent verified by him, though they were full, true and correct, and there was no one within many miles of the mine who could administer oaths, and the directors acted in good faith, and had been advised by counsel that it was not necessary to have them verified. Under such statute, it is not necessary to prove damages. They will be implied from its violation.—Shanklin v. Gray, 43 Pac. Rep., 300.

Elevated Railways and Damages to Abutting Property.

The New York Court of Appeals recently said: The elevated railroad companies are entitled to receive from the courts ample protection in view of the numerous actions they are called upon to defend, and the vast amounts involved in their determination, and judgments against them ought not to be upheld resting upon mere speculation unsupported by evidence; but, on the other hand, parties whose property may have experienced a small advance in fee and rental values since the completion of the elevated road ought not to be remediless when all the facts render it clear that property along the line of such road has been damaged by the interference with the easements of light, air and access, and has for that reason failed to share the advance in values of adjacent property, manifestly due not only to the construction of the elevated system, but to that natural growth which the neighborhood would have experienced by reason of the increase of population and business in a great city, even if the railroad had never been constructed.—Malcolm v. New York El. Ry. Co., 41 N. E. Rep., 793.

Payments to Contractors for Public Buildings.

Where the legislature required that a contract for the erection of a public building should be let to the lowest bidder, but limited the cost, and the contract was let to one who bid less than the amount of appropriation, but afterwards contracted with the commissioners having charge to make some alterations for which he was to look to the state for the additional cost, the difference between the sum bid and the amount of the appropriation cannot be recovered, as such additional contract was not binding on the state, because not let in manner prescribed by law. —Nichols v. State (Ct. Civ. App. of Tex.) 32 S. W. Rep., 452.

Admissibility of Record of Surveys.

The record of a survey by a county surveyor in subdividing a section which neither shows for whom the survey was made, nor the variation of the magnetic needle from the true meridian, as required by the laws of Michigan, and which does not purport to fix definitely the center of the section, is not admissible in evidence.

And though the laws of that state provide that the certificate of the county surveyor of any survey made by him shall be presumptive evidence of the facts therein stated, yet when other surveys made by competent surveyors are introduced in evidence the survey of the county surveyor is of no more binding force than the others.—Van Der Groef v. Jones (Supr. Ct. of Mich.) 65 N. W. Rep., 602.

Civil Engineer Has a Lien.

A civil engineer who makes field notes, maps, charts and drawings, while employed by a corporation in and about the construction of an irrigating canal, on books and papers furnished by the corporation, is entitled to a lien on such field notes, maps, charts and drawings, and has a right to retain possession of the same until he is paid for making them. It does not make any difference whether he was employed by the day or the month, or whether he was employed to make the field notes, etc. —Amazon Irrigating Co. v. Briesen, 41 Pac. Rep., 1119.

Appliances on Electric Street Railways.

An electric street railway is not required to have in use the latest improvements which have been devised to prevent collision with vehicles and pedestrians, but only to use reasonable care to avail itself of new inventions and improvements known to it.—Richmond Ry. & Elec. Co. v. Gartright (Sup. Ct. App. of Va.) 24 S. E. Rep., 267.

Recovery of Excessive Charge from Gas Company.

Where an ordinance provides that a gas company shall not charge consumers more than a certain rate, payment by a private consumer of a charge in excess of such rate may be recovered, though no right of action in his favor is given by the ordinance.—Pingree v. Mutual Gas Co. (Supr. Ct. of Mich.) N. W. Rep., 61.

Construction Company Liable for Neglect of Foreman.

Whenever the nature and magnitude of an undertaking, whether it be of construction or otherwise, are such that it is necessary that orders be given regulating the conduct of employees, and directing them where to work, it is not only the right, but the absolute duty of the employer of such men to give the orders; and in obeying such orders the employees have a right to assume that he has exercised due care for their safety; and where the orders are given by a foreman, who has authority to employ and discharge such men, the foreman is a vice principal, and the employer himself is liable for the negligence of the foreman.—Carlson v. N. W. Tel. Exch. Co. (Supr. Ct. of Minn.), 65 N. W. Rep., 915.

Injunction Will Not Lie Against Sewer Construction.

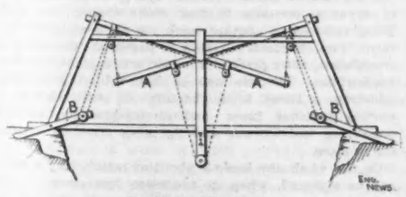
Where a village constructs a sewer that empties the village sewage into a natural water course outside of the village limits, the owner of the lands across which such water course runs cannot enjoin the construction and use of such drain, unless it is proved to be a nuisance. The dismissal of such a bill should be without prejudice, as the sewer may become a nuisance afterwards.—Robb v. Village of La Grange (Supr. Ct. of Ill.) 42 N. E. Rep., 77.

Railway Ownership of Surveyed Routes.

The Supreme Court of the United States holds that a company which surveys a line over public lands beyond the termini fixed by its charter, and afterwards files supplemental articles of incorporation authorizing an extension covering the survey, acquires no right of way beyond such termini, under the laws of the United States, as against another company which, having full powers, makes a survey over the same land after the other company's survey, but before the filing of its supplemental articles.—Washington & I. Ry. Co. v. Coeur D'Alene Ry. & Nav. Co., 16 U. S. Rep., 232.

A PUZZLE IN BRIDGE STRAINS.

A prominent bridge company recently received from a remote country town, a crude pencil sketch of what the sender called "a cable bridge" on which he stated he had taken out a "caviett," and was desirous of selling his rights. The pencil sketch has come into our hands, and it is so curious an affair that we have thought it worth while to resketch it, so as to put it into a shape that may be understood, and submit it to our readers. The task of computing the strains in the various members of this funicular absurdity may prove an agreeable pastime to while away an hour in some of these hot summer days. The only legends attached to the sketch to aid in understanding the construction are one to the effect that "butman (abutment!) lever B works on pivot" and lever A "lifts and distributes strain." We are indebted to Mr. Geo. E. Gifford, M. Am. Soc. C. E., for the original sketch, from which our own is prepared.



"A Cable Bridge."

THE FOUNDATIONS OF THE HERR ISLAND LOCK AND DAM, NEAR PITTSBURG, PA.

In the Annual Report of the Chief of Engineers, for 1895, Major R. L. Hoxie, Corps of Engineers, U. S. A., describes the preliminary work for the foundation of the movable dam at Herr Island, near Pittsburg, Pa. This dam is to be a part of a system of slackwater navigation on the Allegheny River, and is also intended to enlarge the harbor room at Pittsburg by forming a pool. The dam is to be of the movable type, and the estimated cost, on the plans approved July 10, 1894, is $600,000.

It was originally planned to enclose the side of the lock and dam within a coffer dam, and work was commenced upon that basis. But on attempting to pump out the enclosure it was found that water came in in large quantities, not only under the dam, but from springs in the bottom, and all attempts to close these by dumping clay and gravel were a failure. The area enclosed by the dam was about 600 by 200 ft., or about three acres of river bottom. The deposit of sand and gravel overlying the rock was about 35 ft. thick, the rock being 45 ft. below the water level, while the plans required an excavation 20 ft. deep below this water surface. The bottom deposit had been worked over for years by sand-diggers who threw back the large stones and coarse gravel after removing the fine sand; this work resulting in a very permeable bottom, with possible channels of comparatively large dimensions extending to unknown distances beyond the limits of the coffer dam.

Under these conditions Major Hoxie deemed the further trial of a coffer dam impracticable, and concluded that the foundation must be laid under water. He now proposed to dredge out the site of the lock to a point 30 ft. below the pool level, and to then drive piles and to these attach plank formers for confining a thick bed of concrete deposited under water and covering the entire area. Upon this concrete foundation walls of the same material would be built up until the weight of these walls and the redeposited sand and gravel between them would be sufficient to balance the head of water to be dealt with in completing the work from this point within coffer dams. All rupturing strains on the floor of the pumped-out lock-chamber would be met by the thickness given to the concrete bed.

This modified plan was approved on Sept. 6, 1894, and a contract for dredging was awarded to the Drake & Stratton Co., of Pittsburg, Pa. At the date of the report, June 30, 1895, the dredging was completed, the encircling piles were driven and divers were putting the concrete forms in place. In connection with this latter work, various somewhat novel appliances were used, and these are here described and illustrated, as taken from the report of Mr. J. W. Arras, one of the assistant engineers in immediate charge:

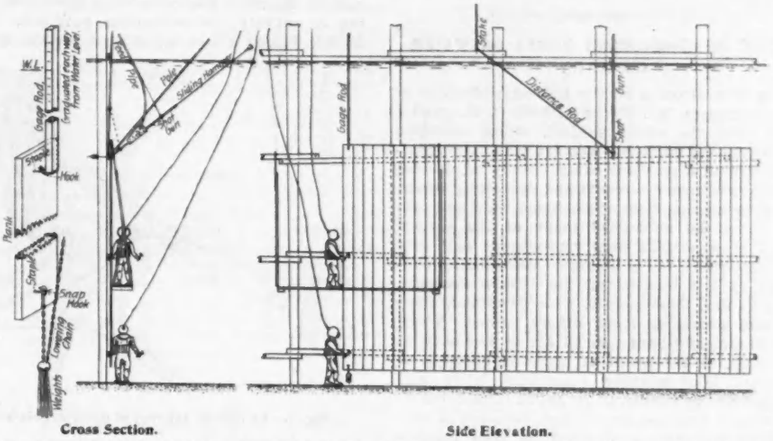


FIG. 1.—METHOD OF ATTACHING PLANKING TO STRINGERS IN CONSTRUCTING UNDER WATER MOLDS FOR CONCRETE WALLS OF HERR ISLAND DAM.

The piles were 40 ft. long and driven in 30 ft. of water; they were weighted at the lower end and hung from a staple in the upper end from the leads of the pile-driver; then lowered, accurately fixed in position by intersecting transit lines and driven, with 2 ft. of each pile extending above the surface after driving. They were afterwards spaced and approximately aligned by spiking temporary wale pieces upon them at the water surface. The bottom stringers, each 4 × 6 ins., and 12 ft. long, were attached to the inside of the piles by three 9-in. spikes in each pile; the upper stringer was in two pieces, one inside and the other outside, each piece 4 × 6 ins., and 20 ft. long, with the 6-in. dimensions horizontal, and they were bolted together with three ¾-in. iron bolts. These top stringers were framed together at the surface of the water, then lowered to position and the nuts on the bolts were finally tightened up by divers working from a platform suspended from the divers' boat. Each pair of stringers covered three piles, and the series overlapped one another at each third pile. A middle stringer was then put in place by divers working from a platform swung from the top stringers.

The 2 × 12-in. hemlock planks were placed vertically. Each plank, 20 ft. long, was put in position by divers, one stationed at the bottom and the other at the middle stringer. Workmen in a boat lowered each plank, with a gage-rod attached to its upper end weighted at the bottom, as shown in Fig. 1. When at the proper height the two divers nailed the plank to the two stringers, and the upper end of the plank, at a point 9 ft. below the surface, was nailed by means of a "shot-gun," which consisted of a hollow tube and sliding hammer, attached to a spike-pole for holding it in position. The spikes were fed down a second pipe when the hammer was partially withdrawn.

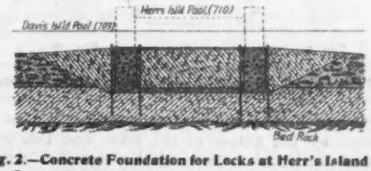


Fig. 2.—Concrete Foundation for Locks at Herr's Island Dam Completed and Ready for Supplemental Coffer Dam.

In this manner two parallel sets of piles and planking were placed in positions, at a sufficient

distance apart to contain within them the concrete foundations for the lock-walls. The floor between these walls being first concreted, as shown in Fig. 2, and when the walls are carried up to a certain height the space between them and the outside of the foundations will be weighted with sand and gravel. Upon this filling coffer dams will be built and the remaining part of the lock-walls will be constructed within this dam.

EFFECT OF ENGINEERING WORKS ON WATER CURRENTS.

At a late meeting of the Canadian Society of Civil Engineers, Mr. Cyrus Carroll, C. E., read a paper upon the above subject, citing examples and cautioning engineers against designing structures without a previous careful study of existing conditions of water currents and prevailing winds.

As showing the effect of combined wind and current action he submitted maps of the several typical river-mouths here reproduced; and said that these maps fairly illustrate the existing conditions at the mouths of the Rivers Saugeen, North Sables, Penetangore, Pine, Maitland, Bayfield and nearly a dozen others named. These maps show sand-bars formed across the ends of the valley, as the result of opposing currents of river and lake meeting, sometimes fairly and squarely, but generally at an angle. These opposing currents join and form a new direction of current with an angle determined by their relative forces.

The sand-bar begins at the windward side of the valley and in time extends across it, crowding the river towards the leeward bank. As a consequence the channel is often narrow and deep when it crosses the bar, and the bar itself grows on the windward side by lake silt washed against it. The lake bank, below the river, is usually cut away.

Fig. 2 shows the utilization of one of these rivers as a harbor, by building out piers or jetties to deep water. They cannot always be entered in a storm; but vessels can seek the shelter of the lee side of the longer piers. Mr. Carroll strongly advises against attempts to form a new channel through the bar and cites Fig. 3 as an illustration of the effect of such a change in channel.

Lakes Burwell and Smith were once portions of Lake Huron; but in comparatively recent times they were cut off from the greater lake by sand dunes now extending out about four miles from the old shore of Lake Huron. Through these dunes the Aux Sables River reached the lakes by a very circuitous route. When the small lakes were first cut off by the dunes the river flowed

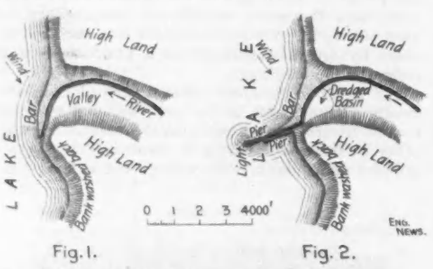


Fig. 1. Fig. 2.

Figs. 1 and 2.—Typical River Outlets on Lake Huron.

northerly, as the dunes were extended in this direction by the action of the lake, and this continued until the nature of the shore at Grand Bend turned the river nearly due west. There the lake current opposed it from the northwest and a bar was formed which gradually forced the river close up along the foot of the sand dunes, and it took a general southwest direction, as shown. Had the river not been interfered with it would probably have reached Kettle Point, where the dunes ceased.

In 1872 a contract was let for the excavation of the Burwell Canal, which was intended to act as a drain to reclaim about 16,000 acres of land covered by these lakes. The canal cost about $80,000, and the result was disappointing. Lake Burwell lies about 4 ft. above Lake Huron, and as soon as a trench was made the water rushed out with such force as to excavate a channel about ⅛ mile wide. The great quantity of sand carried down stopped up the old mouth of the river and a new outlet was formed further north. New mouths were being continually formed as the old ones choked up from sand, and each one to the north of that preceding it. The general result was that only 1,000 acres of land was sold as reclaimed, and the regimen of the river was completely destroyed, spoiling it entirely for navigation purposes. Every freshet brings a new lot of sand for the river to

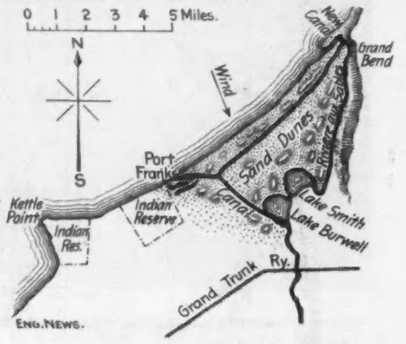


Fig. 3.—An Unwise Attempt at River Regulation.

work through as it may, and while Lake Burwell is dry in summer, Lake Smith still covers two-thirds of its former area. The old channel, between Grand Bend and Port Franks is filled up for considerable distances, and the lands near Grand Bend are subjected to more floods than ever before.

In 1892 a new channel was cut through the beach at Grand Bend, at a cost of $21,500; but as soon as it was completed a beach began to form across the mouth and is now extending southward again along the base of the old dunes and parallel to the old channel, as shown in Fig. 3.

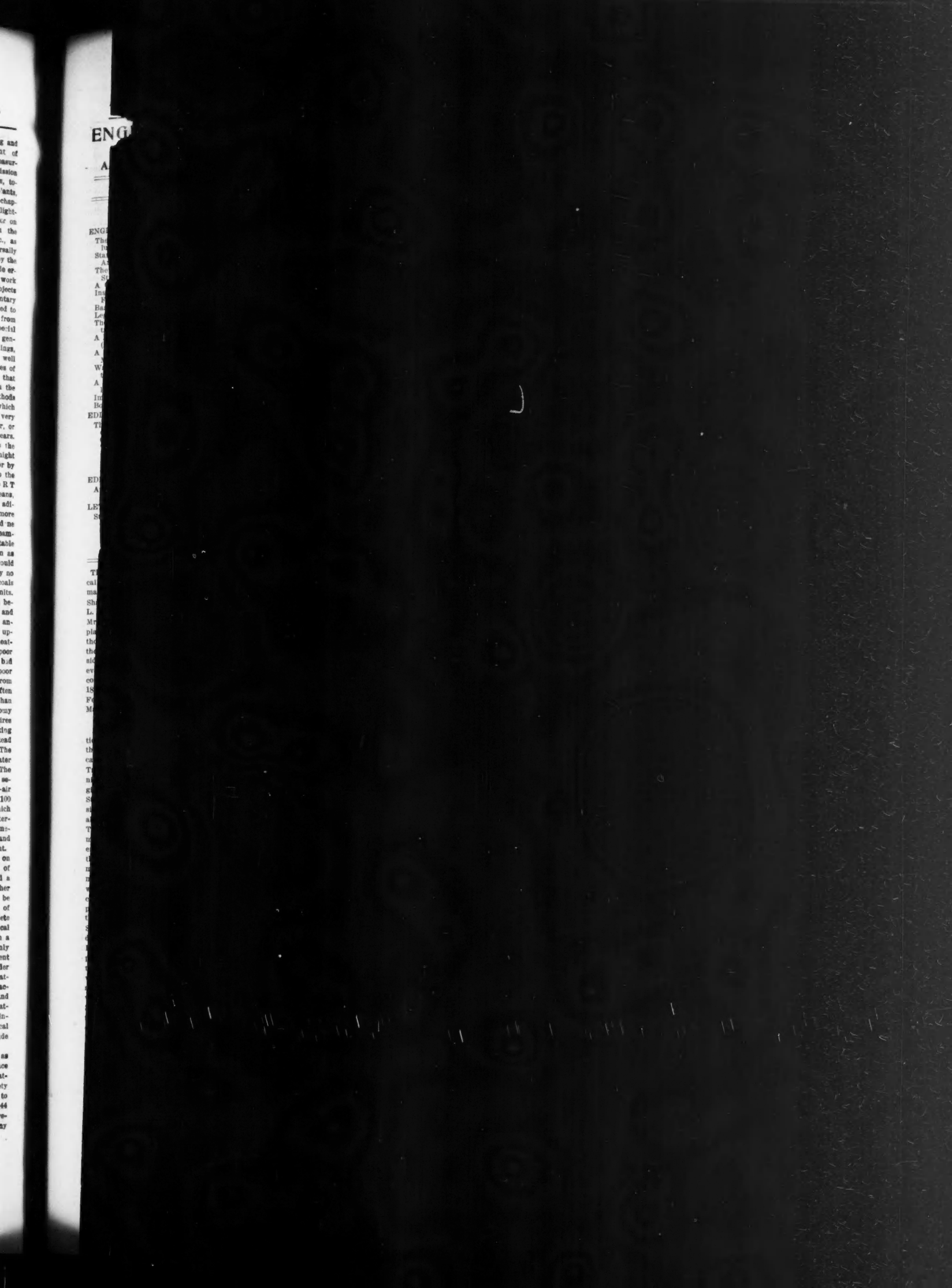
BOOK REVIEWS.

MODERN METHODS OF SEWAGE DISPOSAL for Towns, Public Institutions and Isolated Houses.—By Geo. E. Waring, Jr., M. Inst. C. E. Second Edition, Revised. New York: D. Van Nostrand Co. London: Sampson Low, Marston & Co. 12mo.; cloth; pp. 253; 22 illustrations; $2.

The first edition of this book was favorably noticed in our issue of Oct. 11, 1894. The only change which we can discover in the present edition is the re-writing of Chap. XIII., "Filtration with Aeration," so as to exclude all reference to other investigations of the subject and deal wholly with the author's experiments along this line at Newport. A footnote to p. 147 states that a report describing these experiments in detail "will be sent, without cost, to readers who desire it, upon application to the author at Newport, R. I.," so, obviously, no one who has the first edition need buy the second on account of the changes noted. The original edition, having been published before the Newport experiments were made, contained no reference to them, but interesting as they are it seems a pity to have sacrificed all the matter relating to other researches on the subject in order to have more space for the Newport studies, especially when the report named is available for all interested in the matter.

ELECTRIC LIGHTING.—A Practical Exposition of the Art, for the Use of Engineers, Students and others interested in the Installation or Operation of Electrical Plants. Vol. I, The Generating Plant. By Francis B. Crocker, E. M., Ph. D., Professor of Electrical Engineering in Columbia University. New York: D. Van Nostrand Co.; London: E. & F. N. Spon. 8vo.; pp. 444. $3.00.

The development of electric lighting until quite recently has been so rapid that any complete treatise on the subject would become out of date while it was being printed. At the present time, however, in the opinion of the author of the work before us, electric lighting has reached a sufficiently perfected and established state to allow of its being treated in a fairly satisfactory and permanent manner. The apparatus and methods employed are almost as well standardized as in other arts. The dynamo is one of the most perfect machines in existence. Arc and incandescent lamps, overhead and underground wires, transformers, and almost all the other parts of electric lighting plants have also become sufficiently stereotyped. The plan adopted in this work is to follow the sequence in which the electric current is generated, transmitted and utilized. The present volume treats of the generation of electric current, including location of plant, buildings, steam boilers and engines; gas, oil and hot-air engines; water-wheels and windmills; direct coupling, belting and shafting; principles, construction and management of dynamos; accumulators, switchboards, electrical measuring apparatus and lightning arresters. The transmission and utilization of the current for lighting purposes, together with descriptions of typical electric lighting plants, are reserved for the second volume. The first two chapters treat very briefly of the advantages of electric lighting and of its history, then follows a short chapter on general units and measures, in which are given the definitions of the "international" volt, ampere, etc., as given in an act of Congress in 1894, and now universally adopted, together with the specifications prescribed by the National Academy of Sciences for the practical determination of the ampere and volt. The present work differs from nearly all other works on electrical subjects in not devoting any space to discussion of the elementary principles of electricity, the reader being recommended to acquire a general knowledge of these principles from other works before undertaking the study of a special branch, such as electric lighting. The location and general arrangement of electric lighting plants, buildings, foundations, etc., are treated in his brief, but well written chapters. A discussion of the possible sources of electrical energy follows, in which the author states that the possibility of generating electricity directly from the combustion of coal more cheaply than by present methods is not encouraging. The hope of a new method by which electricity can be gotten directly from fuel-energy is very indefinite at present. It may be realized in one year, or perhaps not for a hundred, or even a thousand years. The steam-engine, history and general principles, is the heading of a chapter of only six pages. The book might be improved by leaving out this chapter altogether, or by considerably enlarging it and making it more clear to the general reader. We do not see why the formula $p v = R T$ is given on p. 92, when it is not stated what R means, nor why the differential formulas for isothermal and adiabatic expansion are given on p. 93, when the much more useful, practical formulas for calculating the work done in an engine cylinder are omitted. The chapter on steam-boilers covers 32 pages, and is fairly good. In the table of heating powers of coal, p. 94, bituminous is given as 8,000 centigrade heat units. A more correct statement would be from 5,000 to 7,500 heat units, as there is probably no bituminous coal in this country (semi-bituminous coals excepted) which have a heat value of 8,000 heat units. Writers of text books should make a clear distinction between the semi-bituminous coals, such as Cumberland and Pocahontas, which have a heating value higher than anthracite, and bituminous coals containing 30% and upwards of volatile matter, which have a much lower heating value. The author's statements that the use of a poor quality of coal on account of cheapness is usually bad economy, and that a larger boiler is required with poor coal to produce a given amount of steam, are far from being generally true. A poor quality of coal is often found in some markets to have a price much lower than that due to its quality, and in such cases great economy is often effected by its use. A poor coal usually requires a larger grate surface than a good coal, the use of shaking grates instead of plain grates, or the use of forced instead of natural draft, but not necessarily a larger boiler. The size of boiler required depends upon the amount of water to be evaporated, and not upon the quality of coal. The chapters on steam-engine construction, typical forms, selection, installation and management, on gas, oil and hot-air engines, and on water-wheels and windmills, occupy 100 pages of the book, and contain much information which may be useful to electrical engineers and others interested in electric lighting plants. The chapters on mechanical connections between engines and dynamos, and on toothed, friction and other gearing, are also excellent.

The strictly electrical portion of the work begins on p. 265 with a chapter on principles and construction of dynamos, which occupies 56 pages. In it is condensed a great quantity of useful information, although it is neither sufficiently elementary in its method of treatment to be read with satisfaction by those not already possessed of a considerable knowledge of the subject, nor complete enough to take the place of other treatises. Typical forms of dynamos for electric lighting are described in a brief chapter of 19 pages, which properly includes only the well-known modern forms. The practical management of dynamos occupies another short chapter, the reader being referred to another work for more complete treatment. Two chapters, covering 40 pages, are devoted to accumulators, their principles, construction, management and applications. The treatment of these subjects is quite satisfactory. Three brief chapters on switchboards, including switches, fuses and circuit-breakers, electrical measuring instruments, and lightning arresters, conclude the volume.

On the whole the book is about as satisfactory a one as can be expected, when its necessary limitations of space and price are considered; in other words, the field attempted to be covered is so vast and has such a variety of detail in every part of it that it is scarcely possible to do it justice in the narrow compass of a $3 book of 444 pages. Prof. Crocker has done as well, within the prescribed limitations, as could be done probably by any writer on electrical subjects.